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 Biological Building, State Univ., Columbus, Ohio.

ANNALS
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Volume VI

JUNE, 1913

Number 2

A REVISION OF THE NORTH AMERICAN SPECIES OF
MEGASTIGMUS DALMAN.

C. R. CROSBY.

The genus *Megastigmus* was founded by Dalman in 1820 (Svensk. Vet.-Akad. Handl. XLI, p. 178) as a subgenus of *Torymus* to contain the three species: *bipunctatus* Swederus, *collaris* and *chloronotus*. *Collaris* was described by Boheman after Dalman's death in 1833 (Svensk. Vet.-Akad. Handl., p. 332). *Chloronotus* was never described but Boheman placed it under *Torymus* (*Megastigmus*) *dorsalis* Fabricius (l. c. p. 334). The type of the genus therefore cannot be *M. dorsalis* as stated by Ashmead (Chalcis-flies, p. 380, 1904) but must be *M. bipunctatus* Swederus since that is the only one of the three species cited by Dalman which was described at that time.

Megastigmus is distinguished from other *Torymidae* occurring in North America by the enlarged and pigmented stigmal club and by the presence of a well developed basal vein. The posterior tibiae have two well developed apical spurs as in other *Torymidae*; Ashmead's table to the subfamilies (Chalcis-flies, p. 236, 1904) is in error on this point, and this mistake has been copied by Schmiedeknecht in *Genera Insectorum*, fasc. 57, p. 118, 1909. The mandibles have three teeth. The scutellum has a fine cross furrow as in *Syntomaspis*. The ovipositor, except in two species, is longer than the abdomen, slender and gently curved upward. The coloration in the American forms is never metallic; usually yellowish brown or opaque blackish.

As far as known the larvæ of all our species live in the seeds of plants.

FEMALES.

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M. jacipex A. L. 1886) was described from males only.

Megastigmus brevicaudis Ratzeburg.

Megastigmus brevicaudis Ratzeburg, Ichneum. Forstinsect., III, p. 225. 1852.

Megastigmus brevicaudis Rodzianko, Comment. Torm., pp. 608-611. 1908.

Megastigmus brevicaudis Crosby, Cornell Exp. Sta. Bull., 265, pp. 375-377, Figs. 77-79. 1909.

Megastigmus brevicaudis Rohwer, U. S. Bur. Ent., Tech. Bull. 20, pt. VI, p. 159. 1913.

Female. Length, 2.4 mm.; abdomen, 1 mm.; ovipositor, .7 mm.

Face, cheeks and a partial ring around eye yellow. Vertex and occiput very dark brown, nearly black. Vertex finely transversely rugulose.

Prothorax yellowish, indistinctly marked with dusky on the sides. Rest of the thorax nearly black with a dull yellowish tinge showing through on the scapulae and scutellum. Antennae brownish yellow; scape and pedicel black above and yellow beneath. Anterior coxae yellow; middle and hind coxae brownish; rest of legs light yellowish. Wings hyaline; stigmal club not surrounded by a clouded area.

Abdomen brownish on the sides, nearly black above. Ovipositor short, dark brown.

Described from 1 ♀, Ratzeburg's type. I have three females reared by W. N. Rodzianko from the seeds of *Sorbus aucuparia* at Poltawa, Russia, which agree very closely with the type.

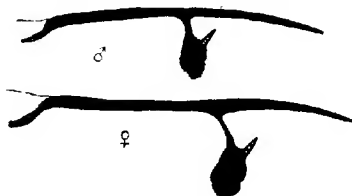


Fig. 1. *Megastigmus brevicaudis*.

Through the kindness of Mr. A. G. Hammar I received some *Sorbus* berries from Sweden from which 5 females were reared. In these specimens the head is black with the face dark honey-yellow. Prothorax honey-yellow, rest of thorax black. Antennæ very much darker than in the type. Abdomen black with brownish bars on the sides. Rodziunko states that he has never been able to rear the male.

I have reared this species abundantly from the seeds of *Sorbus* in New York State. The American specimens are slightly smaller than those from Europe and vary greatly in color, but I have been unable to find any constant character by which they may be separated. The darker individuals are very close to the typical form. A large proportion of the specimens are of uniform brownish yellow. The legs are light yellow and the antennæ and ovipositor are brownish. Between these and the typical form all gradations occur.

Male.—Length, 1.7 to 2.1 mm.; abdomen, .7 to .8 mm. All the males reared are much darker than the females. The face and cheeks are yellow; the legs dull yellowish and the antennæ more yellowish than in female. Head and thorax black except a small spot on each side between the ocelli and the eyes and an area on the lateral aspect of the prothorax, which are brownish yellow. Stigmatal club surrounded by a very narrow clouded area.

Abdomen compressed, seen from the side, elongate triangular, rounded behind, brown-black above and yellowish brown beneath and at apex.

The larva is white, and its mandibles have four teeth on the inner margin.

In addition to rearing the adult insect at Ithaca, infested berries of the Mountain Ash have been found at Weedsport, Jamesville and Wayland, N. Y.

In the National Museum collection is a female specimen from Mt. Washington bearing Ashmead's manuscript name *Megastigmus slossonæ* which agrees exactly with the lighter specimens reared from *Sorbus* seeds from New York State. In the National Museum there is also a very dark ♀ from Oswego, N. Y., 1 July, 1897.

As suggested by Mayr. (Verh. zool.-bot. Ges. Wien, XXIV, p. 139. 1874) this species may be the same as *M. bi-baculatus* Boheman.

Megastigmus physocarpi n. sp.

Female.—Length, 1.8 mm.; abdomen, .8 mm.; ovipositor, .8 mm.

Head and prothorax yellow, rest of thorax and abdomen brownish yellow, the latter much darker. Head and prothorax delicately transversely rugulose; mesothorax with a more pronounced sculpture; propodeum closely but distinctly reticulate, a distinct median carina present. A brownish line connects the ocelli.

Scape yellow; pedicel dusky above, yellow beneath, rest of antennae dusky. Legs including coxae light yellow. Wings hyaline. The stigmal club is narrow and elongate; not surrounded by a clouded area.

Most of the females agree with this description but there are three specimens in which the ovipositor is not over half the length of the abdomen. In these specimens the prothorax has a median black stripe narrower behind and the rest of the thoracic dorsum is black except the scapulae and the posterior part of the propodeum.

Male.—Length, 1.6-1.9 mm.; abdomen, .7 mm.

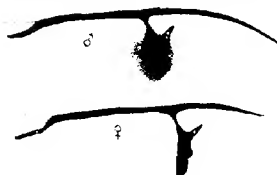


Fig. 2. *Megastigmus physocarpi*.

Similar to the female in color except the abdomen is more or less dark brown above, the antennae are paler and the brown line connecting the ocelli is lacking. Stigmal club surrounded by a dark, nearly circular clouded area.

There are three males marked with black like the females with the short ovipositor. The abdomen is nearly black above except at tip.

Described from 15 females and 6 males from Allentown, Mo., October, 1893, and 1 male from Kirkwood, Mo., 1 July, 1895. All reared from *Physocarpus opulifolius*, probably from the seeds.

Megastigmus nigrovariegatus Ashmead.

Megastigmus nigrovariegatus Ashmead. Bull. Colorado Biol. Association, I, p. 26, 1890.

Megastigmus nigrovariegatus Cockerell. Bull. 15, Ariz. Exp. Sta., p. 69, 1895.

Megastigmus audeatus Crosby. (in part.) Cornell Agr. Exp. Sta., Bull. 265, pp. 377-379. Figs. 82, 83, 1909.

Female.—Length, 3.4 mm.; abdomen, 1.6 mm.; ovipositor, 2.5 mm.

Vertex, antennal grooves and a spot above clypeus dark brown; face and anterior and dorsal eye margin dull brownish yellow; cheeks posterior eye margin and occiput shining brownish.

Prothorax bright yellow posteriorly and on the sides, brownish in front on the lateral angles and just above the front coxae. Mesonotum

brownish yellow, dark brown in front. Mesopleurae brown. Post-scutellum yellow in the middle, brown on the sides; scutellum brown in front of the furrow, yellow behind. Propodeum brown, finely reticulate punctate, with a pair of strongly curved carinae most distinct posteriorly marking off a nearly circular central area.

Scape and pedicel yellow beneath, rest of antennae dark brownish. Legs pale yellow; posterior coxae at base brownish; posterior femora slightly tinged with brownish. Wings hyaline; stigmal club surrounded by a distinct oval cloud.

Abdomen brownish above, sides brownish yellow, indistinctly marked with darker brownish. Ovipositor black.

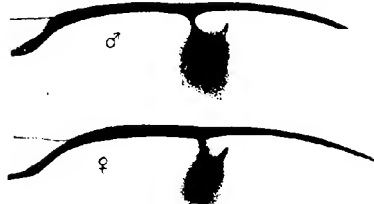


Fig. 3. *Megastigmus nigrovariegatus*.

Described from one ♀, Vancouver Island, a paratype.

In some specimens the yellowish band around the eye is complete. Sometimes the brownish area above the clypeus is lacking and the posterior femora are entirely yellow.

Male.—Length 2.8-3mm.; abdomen .9-1.4mm. (Measurements taken from alcoholic specimens). The males vary greatly in size and color. The lighter males resemble the females closely in color. Sometimes the head is all yellow except the upper half of the occiput, in others it is black except the face and portions of the ring around the eye. In some the thorax is as light as in a female, while in others it is nearly black except an irregular area on the disk and two greenish yellow spots near the posterior margin of the pronotum. In most of the males the propodeum is dark brown to black, but in the lightest specimens it is yellow. In the darkest specimens the abdomen is nearly black except the yellow tip. In the light specimens the legs are yellow, in the dark ones they are more or less brownish on the femora and tibiae. Stigmal club much larger and darker than in female and surrounded by a clouded area.

In the National Museum collection in addition to the paratype and 4 ♀♀ from Vancouver Island are the following specimens belonging apparently to this species. 1 ♀, Algonquin, Ill., June 27, 1894. Labeled "Type, *Megastigmus illinoensis* Ash." 3 ♀♀, Jamaica Plain, Mass. (J. G. Jack). 1 ♀, Natrona, Pa.

1 ♀, Pullman, Wash., 30, June, 1898 (C. V. Piper) "Reared from *Clisiocampa plumalis*." This specimen is imperfect, having lost the abdomen and may not belong here.

Cockerell captured specimens of this species on rose hips in Arizona and suggested that they may possibly breed in them. I have reared this species abundantly from rose seeds from Ithaca, White Church, and Wellsville, N. Y., Waukegan, Ill., Durham, N. H. (Charles Spooner), Boston, Mass. (Ralph Curtis), Provo, Utah (R. V. Chamberlin), and Newark, Del. (C. O. Houghton). Professor J. G. Sanders sent me specimens reared from the seeds of *Rosa rugosa*, at Madison, Wis. Mr. Nathan Banks has sent me 9 specimens reared from rose hips at Falls Church, Va.

Some of these localities are listed under *M. aculeatus* in Cornell Exp. Sta. Bull. 265 because at that time I had not separated these two species. It is probable that *nigrocariegatus* is the native American species infesting rose seeds and that *aculeatus* has been introduced recently, since I have reared it from material collected at Ithaca only.

Megastigmus pinus Parfitt.

Megastigmus pinus Parfitt. Zoologist, pp. 5543, 5545, 5629, 1857.

Megastigmus pinus Rohwer. U. S. Bur. Ent., Tech. Bull. 20, pt. VI, p. 160, 1913.

Female. Length, 4 to 5 mm.; abdomen, 2.3 mm.; ovipositor, 5 to 5.5 mm.

Vertex and occiput black; face, cheeks and a ring around eye yellow, the latter broadly interrupted by the black of the vertex which attains the eye-margin below the level of the front ocellus; antennal furrows black; below the insertion of the antennae there is a circular area cut off from the rest of the face by two or four brownish spots, very variable in shape and distinctness; hairs on the face light colored, above the base of antennae, brown. Vertex and front transversely rugulose; cheeks and lower part of occiput smooth; face with lines radiating from the clypeus.

Prothorax black, with the sides and a large posterior dorsal band greenish yellow; this band is usually biconvex in front. Mesothorax black with an oblong reddish orange area covering the posterior half of the middle lobe, the inner angles of the scapulae and axillae and all of the scutellum. In some small specimens this orange area is obscured by blackish in the center. Sculpture of mesonotum distinctly transversely rugulose. Scutellum with the transverse stria distinct. Pleurae black, scapulae have a large greenish yellow spot in front of tegulae. Postscutellum black with a transverse median band of light yellow. Propodeum black, irregularly rugose with a delicate median carina.

Scape yellow below, black above; pedicel black above, paler at tip beneath; rest of antennæ brownish. Front coxæ yellow; middle coxæ yellow in front, black behind; hind coxæ black; legs yellowish, the middle and hind pairs successively darker; a brownish stripe on outside of posterior femora. Spines on posterior tibiae white and small. Wings hyaline, no cloud surrounding stigmal club.

Abdomen strongly compressed. Segments 2, 3 and 4 brownish black above, polished; rest of abdomen yellow to yellowish brown with a row of large brownish black spots on each side; segment 8 and ventral keel brownish black. Ovipositor brown and strongly curved.

Male.—Length, 3 mm.; abdomen, 1.3 to 1.9 mm.

Head marked as in female but there are no brownish spots below the insertion of the antennæ. Thorax black; median orange-red area lacking; prothorax has the sides yellow and there are two widely separated transverse dull yellowish spots near the posterior margin; usually the outer angle of the scapulae has a yellow spot in front of the tegulae. Stigmal club surrounded by a very narrow clouded area.

Abdomen shorter than in the female, somewhat compressed, seen from above distinctly clavate, yellow beneath, black above, tip orange yellow.

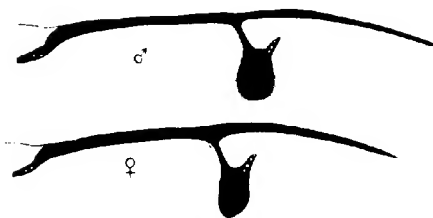


Fig. 4. *Megastigmus pinus*.

This species was first described by Parfitt from females only reared from seeds of *Picea bracteata*, *Pinus Abies nobilis*, and a new species of *Thuja* from California. In a later article he described the male reared from another lot of seeds. Mr. Charles O. Waterhouse of the British Museum has very kindly sent me four specimens which he had carefully compared with Parfitt's types. He also sent me three male specimens of *M. spermotrophus* which he had found to agree with the types from which Parfitt drew his description of the male of *M. pinus*. Ashmead seems to have been misled by this description of the male of *M. spermotrophus* as the male of *pinus* when he states (*Chalcid-flies*, p. 244) that the two species are identical.

2 ♀, 2 ♂ C. O. Waterhouse (Col. British Museum); 16 ♀, 19 ♂ reared from cones of *Abies nobilis*, Astoria, Oregon. No. 5818, Nat. Mus. The following specimens were reared by

Mr. Herman Borries, of Copenhagen, from seeds from the Western United States: 3 ♀ reared from *Abies magnifica* and *concolor*; 1 ♀, 1 ♂ from *A. grandis*; 2 ♀, 1 ♂ from *A. amabilis*. I have also examined the following specimens from the U. S. Bureau of Entomology through the kindness of Mr. S. A. Rohwer. 15 ♀ and 12 ♂ reared from the seeds of *Abies magnifica* from Tahoe, Calif. National Forest. 2 ♀ and 6 ♂ reared from the seeds of *Abies concolor* from Sierra, Calif. National Forest, 30 May, 1912, collected by J. M. Miller. The specimens from *A. concolor* are somewhat smaller and generally darker in coloration.

The female reared from *A. grandis* by Borries may represent a distinct species but it is impossible to decide from such scanty material. The yellow area on the prothorax is very large, covering nearly the whole dorsal aspect and on the vertex there is on each side a branch of the circumorbital yellow band which curves around behind the lateral ocellus. The male is not in good condition for study.

Megastigmus tsugæ n. sp.

Female. Length, 2.5 mm.; abdomen, 1.1 mm.; ovipositor, 1.8 mm.

Face and cheeks yellow; occiput, vertex and front black; the upper posterior orbits and a spot at the upper angle of the eye yellowish brown. Antennal grooves black. Prothorax black with two angular, widely separated dorsal spots and the anterior half of the lateral part yellow. Rest of the thorax shining black. Mesonotum and scutellum finely shingled.



Fig. 5. *Megastigmus tsugæ*.

Scape and pedicel yellow beneath. Anterior coxae yellow, middle coxae brownish yellow, posterior coxae black; rest of legs yellowish; base of femora and band at middle of tibiae on middle and posterior legs brownish. Wings hyaline; stigmal club not surrounded by a clouded area. Abdomen black with five more or less distinct yellow bands at the sides; tip yellowish. Ovipositor black.

Described from 2 females reared by Mr. Herman Borries from seeds of *Tsuga Mertensiana hookeriana* from the Western United States. Type in the U. S. National Museum.

***Megastigmus lasiocarpæ* n. sp.**

Female.—Length, 3.7 mm.; abdomen, 1.5 mm.; ovipositor, 3. mm.

Thorax and abdomen black. Face and partial ring around eye yellow, a pair of large triangular brownish spots on the face; rest of head black. An elongate light yellow spot on the side of the prothorax. Transverse lateral spots on the sides of abdomen yellow. Head finely rugulose with the lines radiating from the mouth and ocelli. Thorax transversely finely rugulose and shingled.

Antennæ brownish black, scape and pedicel yellow beneath. Legs brownish, posterior femora black except at tip. Anterior coxæ yellow, black at base, the other coxæ black. Wings hyaline; stigmal club not surrounded by a clouded area.

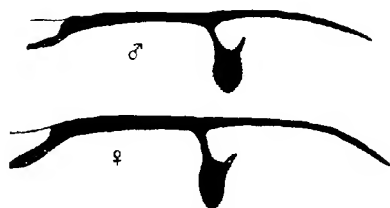


Fig. 6. *Megastigmus lasiocarpæ*.

Male.—Length, 2.4 mm.; abdomen, 1 mm.

Vertex, upper part of occiput and front half way to base of antennæ, black; face, cheeks, lower occiput and a narrow spot along upper eye-margin, yellow. Whole dorsal aspect of thorax black; the yellow spot on side of prothorax is larger than in female. Abdomen black.

Antennæ brownish, scape yellow in front, pedicel nearly black above. Front coxæ yellow, middle coxæ yellow, blackish at base, hind coxæ black. Legs yellowish, suffused with brownish distally; posterior femora brownish on outer surface. Stigmal club darker than in female and more nearly circular.

Described from 2 ♀ 1 ♂ reared from seeds of *Abies lasiocarpa* kindly sent me by O. S. Mackelfresh, from Rye, Colorado, 5 June, 1909.

***Megastigmus spermotrophus* Wachtl.**

Megastigmus spermotrophus Wachtl. Wien. Ent. Zeit., XII, p. 24, 1893.

Megastigmus pinus Parfitt. Zoologist., XV, p. 5731, 1857 (Male only).

Megastigmus spermotrophus MacDougall. Trans. Roy. Arbor. Soc., XIX, pp. 52-65, 1906. Figure and account of habits.

Megastigmus spermotrophus Crosby. Cornell Exp. Sta. Bull. 265, pp. 379-380. Fig. 85-89, 1909.

Megastigmus spermotrophus Rohwer. U. S. Bur. Ent., Tech. Bull. 20, pt. VI, p. 160, 1913.

Female.—Length, 3–3.5 mm.; abdomen, 1.8 mm.; ovipositor, 1.6 mm.

General color a yellowish brown. Face and cheeks lighter than the vertex. Face with fine lines radiating from the clypeus; vertex and thorax finely transversely rugulose. Head and thorax clothed with stiff black hairs arising from black tubercles. Median area on postscutellum, greenish yellow. Propodeum with a distinct median carina.

Antennae brownish, scape yellow beneath, pedicel nearly black above. Legs including the coxae paler than the thorax. The posterior coxae clothed with stiff light-colored hairs, arising from black tubercles. Wings hyaline; stigmal club not surrounded by a cloud; stigmal vein as long as the width of club.

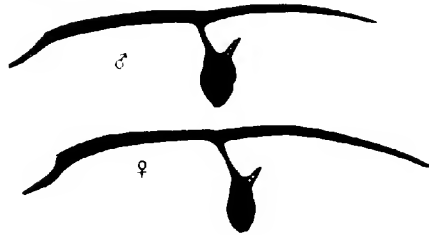


Fig. 7. *Megastigmus spermotrophus*.

Male. Length, 2.9–3.3 mm.; abdomen, 1.2–1.7 mm. (Measurements taken from alcoholic specimens.)

Head, thorax and legs a clearer yellow than in the female. On the front of the pronotum a dark brown spot is sometimes present which is sometimes divided into two. Sometimes the front of the mesothorax is black and shows through the posterior edge of the prothorax. Median and anterior portion of the propodeum black; sides and posterior margin yellow. Stigmal club darker than in female, not surrounded by a clouded area.

Abdomen brownish yellow, black at base above.

Described from numerous specimens of both sexes reared from seeds of the Douglas Fir sent me by Mr. John Crozier, of Aberdeenshire, Scotland.

The egg as obtained by dissection of the female is white, smooth and spindle-shaped with a very long pedicel at the anterior end and the vestige of one at the opposite end. Length of body of egg, .36 mm.; tail like process, .9 to 1.2 mm.

The full grown larva is yellowish white with brownish mouthparts; its length varies from 2.5 to 3.5 millimeters. The surface is smooth without apparent sculpture and the hairs are very sparse and microscopic in size. The inner margin of the mandibles is provided with three sharp teeth.

The pupa is yellowish white and in the female has the ovipositor curved over the back and reaching to about the middle of the thorax. Length of female pupa, 3 mm.; of male, 2.5 mm.

While originally a native of the Western United States it has been introduced into Europe and has there become a serious pest. The male of this species was described by Parfitt in 1857 as the male of *M. pinus*. Mr. Charles O. Waterhouse of the British Museum has kindly sent me three males of this species which he compared with Parfitt's types. Safró (Jour. Ec. Ent., VI, p. 283. 1913.) records rearing this species from seed of Douglas Fir in Washington.

The species listed under B in Riley's article (Proc. Ent. Soc. of Wash, II, p. 360) also belong to this species. They were reared from seeds of *Pseudotsuga douglassi*, [*taxifolia*], *Abies magnifica*, *A. grandis*, *A. amabilis* and *A. concolor*.

Through the kindness of Mr. S. A. Rohwer I have been able to examine specimens from the U. S. Bureau of Entomology as follows: 4 ♀ 4 ♂ reared from seed of *Pseudotsuga taxifolia* from Yreka, Calif., April and May. 3 ♀ 2 ♂ reared from seed of *Abies magnifica* from Tahoe, Calif. National Forest, June, 1912; 1 ♀ 1 ♂ from seeds of *Abies concolor*, from Sierra, Calif. National Forest (J. M. Miller, Collector).

Megastigmus aculeatus Swederus.

- Pteromalus aculeatus* Swederus. Vetensk. Akad. nya Handl., XVI, p. 221. 1795.
Erginus collaris Boheman. Vetensk. Akad. nya Handl., LIV, p. 332. 1834.
Megastigmus transversus Walker. Ent. Mag. I, p. 117. 1833.
Erginus punctum Förster. Beitr. Monogr. Pteromal. p. 29. 1841.
Megastigmus vexillum Ratzeburg. Jchn. d. Forstinscet. II, p. 182. 1848.
Megastigmus transversus Reinhard. Berl. Ent. Zeitschr., I, p. 76. 1857.
Megastigmus flavus Förster. Verh. Nat. Ver. preuss. Rheinl. XVI, p. 109. 1859.
Megastigmus collaris Mayr. Verh. zool.-bot. Ges. Wien. XXIV, p. 137. 1874.
Megastigmus aculeatus Thomson. Hymen. Scand. IV, p. 1. 1875.
Megastigmus cynorrhodi Perris. Ann. Soc. Ent. Fr., 1876, p. 222.
Megastigmus aculeatus Cameron. Trans. Ent. Soc. Lond., 1879, p. 118.
Megastigmus collaris Wachtl. Wien. Ent. Zeit., III, pp. 38, 39. 1884.
Megastigmus aculeatus Crosby. (In part). Cornell Exp. Sta., Bull. 265, pp. 377-379. 1909.

Female.—Length, 3 mm.; abdomen, 1.5 mm.; ovipositor, 4 mm.

General color brownish yellow. Face and cheeks yellow; vertex brownish yellow; occiput with a narrow band of black above the opening. Pronotum pale yellow behind, mesonotum black in front where it shows through the thin posterior edge of the pronotum, the anterior half reddish yellow; axillæ black except the inner angle; anterior half of the propodeum black or dark brown. Median carina of propodeum not pronounced. Median part of the postscutellum greenish yellow.

Antennae very dark brown, nearly black, scape beneath yellow. Legs yellow, wings hyaline. Stigmal club oval, not surrounded by a cloud, the stigmal vein shorter than the width of club.

Abdomen brownish yellow on the sides, dark brown above banded with yellow. Ovipositor longer than body, black and curved.

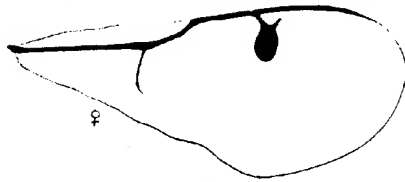


Fig. 8. *Megastigmus aculeatus*.

Described from numerous specimens reared from rose seeds at Ithaca, N. Y. In Bull. 265, Cornell Exp. Sta. I have confused this species with *M. nigrovariegatus*. All the other localities there given refer to that species. Figures S2 and S3 are also of *nigrovariegatus*. In the collection of the U. S. National Museum there is a series of specimens reared from rose seeds imported from Peking, China. I have also reared several specimens from rose hips from Heilbronn, Germany, procured for me by Mr. Carl Ilg from his friend, Mr. Gustav Wieland.

***Megastigmus flavipes* Ashmead.**

Megastigmus flavipes Ashmead. Trans. Am. Ent. Soc. XIII, p. 128. 1886.

"Male.—Length, .12 inch. Head and thorax bright golden green, face finely reticulately strigose; thorax irregularly, transversely coarsely strigose; antennae clavate, scape and flagellum beneath yellow flagellum above brown-black; the collar is rather short; the scutellum at tip is divided by a transverse suture and with a raised rim at border posteriorly; abdomen ovate, black; legs waxy yellow; wings hyaline, veins pale, excepting the stigmal vein, which is brown, and ends in a circular stigma.

"Described from one specimen taken in August."

In the United States National Museum collection there is the pin on which the type was originally tag-mounted. Only the hind legs and one front wing remain. The stigmal club is large, very dark colored and appears to be surrounded by a narrow clearly defined cloud.

In 1888 (Bull. 3, Kansas Agricultural Experiment Station, p. III) Ashmead described another species under the same name, *Megastigmus flavipes*. Through the kindness of Professors T. J. Headlee and G. A.

Dean, I have been able to examine the type of this species. It is a male *Torymus*. As the original description is rather brief I will publish a more complete description elsewhere.

***Megastigmus albifrons* Walker.**

Megastigmus albifrons Walker. Trans. Ent. Soc. London, 1839, p. 311.

Female.—Length, 5 mm.; abdomen, 2 mm.; ovipositor, 1 mm. (abdomen contracted in drying).

Head yellowish white, with many black punctures from which arise black hairs; on the middle of the face the hairs are yellowish; an area including the ocelli and extending almost to the eye margin, black.

Prothorax dull yellowish, the dorsum marked with a wedge-shaped black spot from the front corner of which a black line curves around along the lateral margin and almost reaches the posterior edge of the segment. Central lobe of the mesonotum black except along the lateral edge; lateral lobes brownish, blackish in the center. Scutellum black except along side and at apex where it is yellowish brown. Axillae black in the center, surrounded by yellowish brown. Post scutellum yellowish white in the center, black on the sides. Propodeum black, yellowish white at the sides. Pleurae yellowish white.

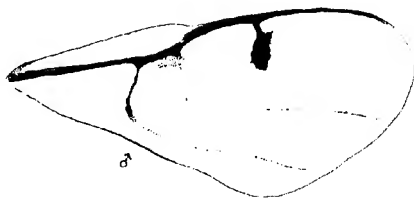


Fig. 9. *Megastigmus albifrons*.

Antennae brownish, scape yellowish at base and below. Legs yellowish brown; tarsi blackish at tip. Front wings hyaline with a distinct brownish spot adjoining the hind margin of the submarginal vein beyond the junction with the basal vein. Basal vein unusually distinct. Stigmal club surrounded by an indistinct clouded area scarcely discernible when viewed with a hand lens.

Abdomen shining black above, spotted with dull-yellowish on the sides and below. Ovipositor black, the extreme tip yellowish.

Male.—Length, 6 mm.; abdomen, 2.5 mm.

Head similar to female. Thorax dull yellowish marked with a black median line, enlarged in front on the prothorax, narrower on the median lobe of the mesothorax and again enlarged on the scutellum. The lateral black marking on the prothorax of the female is here replaced with brownish.

Mesonotum distinctly brownish. Axillæ black along the anterior margin. Legs more distinctly brownish than in the female. In the fore wing the brownish spot adjoining the submedian vein is more distinct than in the female, and the stigmal club is surrounded with a distinct clouded area.

Abdomen shining black above, brownish yellow below.

Described from 1 ♀ and 1 ♂. Placerville, Cal., 8 Feb., 1913. Reared by J. M. Miller from the seeds of *Pinus ponderosa*. Received through the kindness of S. A. Rohwer.

Megastigmus canadensis Ashmead (Trans. Am. Ent. Soc., XIV, p. 186, 1887).

The type in the United States National Museum is a male Pteromalid.

Through the kindness of Dr. Henry Skinner, I have been permitted to examine specimens of the two following species in the collection of the American Entomological Society.

M. cecidomyiæ Ashmead (*l. c.* XIV, p. 185, 1887).

Two specimens, male and female, both tag-mounted on the same pin, "E. Fla., Ashmead" and labeled with the name in Ashmead's hand-writing. They belong to the genus *Lochites*.

M. fœtigera Ashmead (*l. c.* IV, p. 185, 1887). One male. The head is glued to the card point separately. The antennæ are lacking. It is apparently an Encyrtid. "E. Fla. Ashmead." Name in Ashmead's handwriting.

These specimens were probably the ones from which Ashmead drew up his description of the species.

In 1892 C. V. Riley received a series of specimens of *Megastigmus* reared from the seeds of various conifers by Mr. Herman Borries, of Copenhagen, Denmark. He published (Proc. Ent. Soc. Wash. II, pp. 359-363) an article on the habits of this genus in which he gave a list of the specimens reared by Mr. Borries and data in regard to the host plants. I have examined these specimens in the National Museum Collection and for convenience quote the list and indicate the species to which each lot belongs.

"A. Very handsome species marked with black, red, and yellow. II and V from *Abies magnifica* and *concolor*, somewhat smaller and paler; III, from *A. grandis*, distinctly smaller, much paler; IV, from *A. amabilis*, larger and darker. ♂ and ♀ of all varieties. [*M. pinus* Parfitt.]

"B. Entirely yellow species, also variable; perhaps two species: (Red. I, from *Pseudotsuga douglassi* [taxifolia] ♂ and ♀; II, from *Abies magnifica*; III, from *A. grandis*; IV, from *A. amabilis*; V, from *A. concolor*. [*M. spermatrophus* Wachtl.]

"C. Very small, dark species, very similar to small specimens of the European *M. strobilobius*. From *Tsuga* [mertensiana] *hookeriana*. 2 ♀. [*M. tsuge* n. sp.]

"D. Entirely black species from Japan. From *Abies mariesi* 2 ♀. * [*M. borriesi* n. sp.]

"E. *M. strobilobius* Ratzeb. from Denmark. 5 ♀."



Fig. 10. *Megastigmus borriesi*.

**Megastigmus borriesi* n. sp.

Female—Length, about 3.3 mm.

Head, thorax and abdomen dark brown, nearly black; yellowish around mouth. Antennae of the type still in pupal sheaths. Scape brownish lighter beneath. Legs brownish yellow, the posterior femora darker. Coxae dark brown like the thorax. Wings hyaline, the stigmal club without a surrounding cloud. Ovipositor as long as abdomen.

Described from two females in rather poor condition. Reared by Mr. Herman Borries from seeds of *Abies mariesi* from Japan.

TABLE OF HOSTS.

M. holotus Swederus—Rose seeds.

M. albizonis Walker—Seeds of *Pinus ponderosa*.

M. troieundis Ratzeburg—Seeds of Sorbus.

M. borriesi Crosby—Seeds of *Abies mariesi* from Japan.

M. fascipes Ashmead—Unknown.

M. lasiocarpa Crosby—Seeds of *Abies lasiocarpa*.

M. nigrovariegatus Ashmead—Rose seeds.

M. physiocarpi Crosby—Seed capsules of *Physocarpus opulifolius*.

M. pinus Parfitt—Seeds of "*Picea bracteata*," *Abies nobilis*, *Abies magnifica*,

Abies concolor, *Abies grandis*, *Abies amabilis*.

M. spermatrophus Wachtl—Seeds of *Pseudotsuga taxifolia*, *Abies magnifica*, *Abies grandis*, *Abies amabilis*, *Abies concolor*.

M. tsuge Crosby—Seeds of *Tsuga mertensiana hookeriana*.

ACKNOWLEDGMENTS.

My indebtedness to the many persons who have aided me in the preparation of this paper by the loan of specimens and other material and in other ways is duly acknowledged in the preceding pages. My thanks are especially due to the authorities of the United States National Museum and of the Bureau of Entomology at Washington for the loan of many specimens and to Mr. C. O. Waterhouse of the British Museum for an examination of Parfitt's types.

The drawings were all made by Miss Anna C. Stryke, of Ithaca, N. Y.

THE NEUROPTEROUS GENUS PALPARES.

By NATHAN BANKS.

To the genus *Palpares* belongs the most magnificent of the Neuropterous insects. Their large size and contrasting markings has attracted even the collector of butterflies so that now a considerable amount of material exists in the various museums, a much more representative collection than any other group of exotic Neuroptera.

Having recently seen many of the collections and having a number of species in my own, I have endeavored to prepare a table with such notes as may be useful in identifying the various species.

Africa is the home of the genus, two species occur in Southern Europe, several in India and Persia, and one has been taken in the Madeira Islands. Elsewhere there are none, nor even a closely allied genus.

Several attempts have been made to divide the genus. Hagen made *Stenares* for those species in which the costal cells were crossed. This character is often variable in development, in many Myrmeleonidae, but in *Palpares* it appears to be more constant: the species of *Stenares* always have two rows of cells for most of the costal length, while in the true *Palpares* it is rare to find even one cell crossed. *Panexis* was created by Hagen for certain small, broad-winged species, the type of which has a thickened subcosta. Until better characters are given, it is best to keep *Panexis* as only a subgenus.

McLachlan proposed to divide both *Palpares* and *Stenares* according to whether the outer margin of the wings were strongly sinuated or not. Thus *Symmathetes* is for species of *Palpares* with sinuated margin and *Crambomorphus* is for those *Stenares* with a sinuated margin. However as we know more species of *Palpares* it becomes increasingly difficult to tell whether the margin is strongly sinuated or not; thus *P. amitinus*, *P. insularis*, *P. inclemens* and *P. latipennis* all have the margin plainly sinuated, and other species show this character in a slight degree. Lately Navas has proposed various new genera. *Nosa* for *P. tigris* which has apparently two radial sectors, although in reality it has no more longitudinal veins than other Myrmeleonidae. *P. tigris* is so closely related by other characters to species with but one radial sector that I cannot

consider it generically different from *Palpares*. *Palparellus* was made by Navas for *P. spectrum*, but *P. ocampoanus* connects this group with the section of *P. flavofasciatus*.

Golafrus was made for *P. oneili* on account of the emargination at base of the fore wing. I suspect this character exists only in the male sex, besides *P. oneili* is otherwise related to *P. radiatus*.

If these names are to be used for subgenera, others should be created for other sections or groups. In the appended notes I have given certain facts regarding the anal venation which, although not sufficiently different to divide the genus, are fairly constant for each species. The color of the legs is valuable, and I tabulate the black and pale legged species below.

The color of the vertex and the presence of spots on thorax and on abdomen are also very useful. The point of origin of the radial sector in the fore wings is also useful; in *P. libelluloides* it is as far basad as the cubital fork, in many other species it is plainly beyond this point.

The palpi are variable in length according to the species; in *P. libelluloides* the last joint of the maxillary palpi is much longer than the space between the eyes, in *P. speciosus*, *P. moestus* etc., it is shorter. The male appendages also vary in length, but little in structure; in *P. speciosus* and allies they are very short, in *P. tigris* very long and with a basal tooth.

The markings of the wings, although variable in development, are extremely useful, especially the shape of the apical marks. It is doubtful if the character of median band across hind wing is of specific value. The size of species does not vary much, but the width of the hind wings does vary to some extent in the same species. The width of the face between the eyes is very narrow in *Palparellus* and the *flavofasciatus* group, in others wider. In the table I have placed a number of names as synonyms, based (in most cases) on my examination of the types, but I am quite certain that a still greater number should also be placed as synonyms, or at most varieties. All the species allied to *P. speciosus* are probably but forms of that species, for the marks are all on the same plan and the male genitalia the same. Likewise several species will later fall under *P. tristis* as collections are more extensive.

P. cognatus Rbr I have not seen, nor been able to place it; its habitat is unknown.

Arranged according to the color of legs they are as follows:

- Legs all black, or pale on part of tarsi.
speciosus, *caffer*, *digitatus stuhlmanni*, *flavofasciatus*, *festicus*, *formosus*, *amitinus*,
insularis, *spectrum* (and allies) *damarensis*, *tigroides*, *cataraeta*, *immensus*,
contrarius, *pardaloides*.
 Legs with pale on femora or tibiae.
libelluloides, *hispanus*, *pardus*, *inclemens*, *latipennis*, *nyicaeus*, *agrotus*, *tristis*,
tigris, *obsoletus*, *mæstus*, *interioris*, *angustus*, *oneili*, *sparsus*, *radiatus*, *tescellatus*,
furfuraceus, *zebratus*.

The species may be arranged in the following groups:

- palpares* group.
 Includes also *obscuripennis*.
mæstus group.
 Includes *cataraeta*, *martini* and *contrarius*.
flavofasciatus group.
 Includes also *compositus*, *formosus*, *damarensis*, *bifasciatus*, *festicus*, and
elegantulus.
spectrum group.
 Includes also *rothschildi*, *astutus*, and *ocampoanus*.
latus group (*Pamexis*).
 Includes also *translatus* and *contaminatus*.
speciosus group.
 Includes also *digitatus*, *caffer*, *varius*, *stuhlmanni*, and *dubiosus*.
libelluloides group.
 Includes also *papilionoides*, *hispanus*, *percheroni* and *tescellatus*.
agrotus group.
 Includes also *walkerii*, and *angustus*.
tigris group (*Nosa*).
 Includes also *agrotus*, *ornatus*.
pardus group.
 Includes also *tigroides*, *zebratus*.
tristis group.
 Includes also *interioris*, *obsoletus klugi*, *extensus*, *lentus*, *similis*, *pardaloides*,
nigrita.
sparsus group.
 Includes also *sobrinus*, *furfuraceus*, *abyssinicus*, *nyicaeus*.
epholotes group.
 Includes also *inclemens*, *incommodus*, *latipennis*, *radiatus*, *immensus*, *o'neili*,
astarte, *pallens* (*infirmus*), and *harroanus*.
insularis group.
 Includes also *amitinus*.
eggs group.
 No others known.

The African species are tabulated below, after which are the Indian species.

TABLE OF AFRICAN SPECIES.

- Hind margin of fore wings with a long emargination at base; wings narrow, streaked with dark. *o'neili* Per. 2.
- Hind margin not emarginate near base. 2.
- Anterior apical margin of hind wings straight or slightly concave, tip acute; large heavily marked species the outer margin of wings sinuate. *gigas* Dal. 3.
- Anterior apical margin of hind wings convex. 3.
- Hind wings mostly black on the basal part before cubital fork as elsewhere; with only isolated pale spots. 4.
- Hind wings largely pale, and pale on basal part before the cubital fork. 5.

4. Wings slender, acute at tips; hind pair with a pale apical streak.....
karrooanus Per.
 Wings broader, not acute; hind pair without apical streak; several isolated pale spots..... *talitzkowi* Wesm.
5. Vertex dark or blackish, legs wholly black..... 6
 Vertex pale, with a median dark stripe, or at least outlined by pale spots..... 20
6. A large spot at or near the cubital fork in the hind wings..... 16
 No spot near cubital fork in hind wings, the base being all pale..... 7
7. In hind wings the dark extends along the costa to base..... 8
 In hind wings the dark does not extend to base, at most some isolated dark marks..... 10
8. Fore wings with large pale space in the middle, wings rather slender.....
ocampoanus Per.
 Fore wings without a large pale space in middle..... 9
 Both wings with pale post-stigmal bands..... *spectrum* Rtt.
 These bands broken into spots..... *rotschildi* Wesm.
10. Fore wings dark, with black bands; hind wings with nearly two-thirds black with small white spots; expanse over 100 millimeters.....
obscuripennis Sc.
 Fore wings yellowish or hyaline in pale areas..... 11
11. The subcosta of fore wings thickened near the stigma, wings yellow with dark bands, hind wings very broad.....
luteus Thunb.
 The subcosta of fore wings not thickened..... 12
12. Median band of hind wings does not reach up to the radius, but from middle of wing behind in form of three spots..... *contaminatus* Hag.
 Median band of hind wings reaches across the wing from radius to hind margin..... 13
13. Apex of fore wings dark with a distinct pale band before it..... 14
 Apex without such marks..... 15
14. Dark bands of hind wings not connected..... *flavofasciatus* McLach.
 Dark bands of hind wings connected..... *compositus* Navas.
15. Fore and hind wings with apical marks in the form of longitudinal streaks.....
elegantulus Per.
 These marks not in the form of streaks, but band or spots..... *festivus* Germ.
 Small very broad-winged species; greatest breadth of the hind wings much beyond the middle; basal band of the fore wings reaches to the hind margin.....
translatus Walk.
 Larger; wings more slender; greatest breadth of hind wings at middle of length or before..... 17
17. Hind wings with the stigmal band broad and in front in two parts; wings not yellowish; basal band of hind wings nearly across, or in two nearly connected spots..... *cataracta* Per.
 Hind wings with the stigmal band entire on the front margin..... 18
18. Abdomen pale yellowish red; wings yellowish brown; small species; bands of hind wings narrow, apical mark in form of two streaks..... *bifasciatus* Oliv.
 Abdomen pale on base, darker toward tip..... 19
19. Pronotum with yellow each side; fore wings often more or less yellowish, and the median and stigmal bands often only spots with dark borders; thorax very hairy, not showing the pale spots, male appendages very short..... 21
 Pronotum with two yellowish spots on front margin (maybe connected); pale median spots on thorax visible..... 20
20. Few spots between stigmal and median bands in fore wings; apical mark in form of streaks..... *damarensis* McL.
 Many spots between bands; apical mark not in form of streaks..... *formosus* Blas.
21. Bands of hind wings connected together; apical mark of hind wings enclosed but one pale spot..... *stuhlmanni* Kohn.
 Bands of hind wings separate..... 22
22. In fore wings the small basal spots are arranged so as to leave two clear longitudinal streaks; stigmal and median bands of hind wings reach across with two or three fingers each; sides of pronotum more narrowly yellow.....
digitatus Germ.
 Basal spots of fore wings not arranged to leave clear spaces; sides of pronotum broadly yellow..... 23

23. Hind wings tessellate with spots along the hind border 24.
- Hind wings not tessellate with spots along the hind border *dubiosus* Per.
24. Bands of hind wings reach across; wings rather more narrow *speciosus* L.
- Bands of hind wings do not reach across 25.
25. Spots greatly reduced in size *corvus* Nav.
- Spots of moderate size *caffer* Burm.
26. A large spot on the forking of the cubitus in the hind wing 51.
- Only a small dot on this forking, but sometimes there are marks near by, above or around the forking 27.
27. Hind margin of both wings narrowly, evenly fimbriate all along; stigmal spot of fore wings hardly reaches the radius; bands of hind wings not reaching across the wing 28.
- Hind margin of the wings with at most separated dark spots; not evenly fimbriate all along, always some pale spaces 30.
28. Fore wings with apparently two radial sectors arising close together; the lower of the apical spots is triangular; no band below antennae *trigris* Daln.
- Fore wings with but one radial sector; a black band below antennae 29.
29. Stigmal band of hind wings concave within; lower apical mark of fore wings hardly in form of two streaks *ornatus* Nav.
- Stigmal band of hind wings not concave within, often broken; lower apical mark of fore wings in form of two parallel, slightly curved streaks *agrotus* Gerst.
30. Fore wings with many small dark spots, and no large spots or bands 31.
- Fore wings with large spots (perhaps netted) or bands 35.
31. Hind wings with all small spots 32.
- Hind wings with some moderately large spots 33.
32. Longitudinal space behind the first branch of radial sector in fore wing, pale, unmarked *sparsus* McLach.
- This space with spots as elsewhere *subrinus* Per.
33. Vertex greatly swollen; thorax with fulvous hair; spots in hind wings mostly rounded *tortuosus* Rbr.
- Vertex not so swollen; some spots in hind wings in the form of streaks 31.
34. Longitudinal space behind the first branch of radial sector in fore wings mostly unspotted *abyssinus* K.
- This space with spots as elsewhere; hind wings with median spots, a spot or streak beyond and apical streaks *agrotus* Kolbe.
35. Apical marks of hind wings in the form of longitudinal spots or streak 36.
- Apical marks not so; transverse 42.
36. A submarginal line in fore wings 39.
- No such line; bands of hind wings not across 37.
37. Bands of fore wings usually small and faint; hind margin of hind wings with long curved streaks reaching towards the bands; femora not spotted *obedatus* Gerst.
- Bands of fore wings distinct; hind margin of hind wings not so plainly streaked, mostly short spots; femora spotted 38.
38. Larger, spots not broken up much; face mostly black; abdomen not striped *tristis* Hag.
- Smaller, spots more broken up; the male appendages shorter; narrow band below antennae; abdomen striped *interioris* Kolbe.
39. Stigmal mark in the hind wings divided, not reaching across; fore wing with an apical cloud *klugi* Kolbe.
- Stigmal mark in hind wing entire; fore wings with apical streaks 40.
40. Stigmal mark of fore wings in form of a streak; stigmal band of hind wings not across *immemus* McL.
- Stigmal spot of fore wing band-like 41.
41. Stigmal and median bands of hind wings not across *similis* Stütz.
- These bands reach across *reticulatus* Stütz.
42. Median band of hind wings with a projection toward the cubital fork, or else a separated spot near by; stigmal band with upper inner projection and also one behind 43.
- No such projection to median band, nor a separated spot near by 44.

43. Median band of hind wings has a projection toward the cubital fork; large species *latipennis* R. & F.
Median band not with a projection, but a large spot near the cubital fork *inclemens* Walk.
44. Fore wings with four distinct bands; hind wings with straight bands; no dots along hind border of either wing *normalis* Nav.
Fore wings with but three bands; bands of hind wings not straight 45.
45. Median and stigmal bands of hind wings connected *amitinus* Kollar.
Median and stigmal bands separated 46.
46. Median band of hind wings reaches across; bands not netted 47.
Median band does not reach across the hind wing 49.
47. Stigmal band of two more or less connected bands; apical mark of fore wing entire; a large costal sub-basal spot dark; outer margin of wings plainly sinuate *maratus* H.
Stigmal band of but one band, perhaps with projections; no large sub-basal costal spot in fore wings 48.
48. Apical mark of fore wings entire; inner projection of stigmal band of hind wings directed backward *insularis* McL.
Apical mark of fore wings divided; inner projection of stigmal band of the hind wings directed upward *lentus* Nav.
49. Bands netted; median band of hind wings with emargination on the inner side *nigrita* Nav.
Bands not netted; hind wings rather broader in the middle 50.
50. Fore wings with many moderate-sized spots; the stigmal band very small; no other bands; from Madagascar *pardaloides* Weele.
Fore wings with only small dots and bands; median band of hind wings with an emargination on inner side; large spot on middle of hind margin *geniculatus* Nav.
51. Abdomen yellow, each segment with a broad black transverse basal band; no longitudinal stripe; wings broad, fore wings much spotted; in hind wings the bands not across, or only by connected spots *hispanus* L.
Abdomen with the segments not banded, sometimes lineate or spotted 52.
52. Apical marks of hind wings in the form of two streaks 53.
Apical mark of hind wings transverse or in spots 54.
53. Stigmal band of hind wings not reaching across 51.
Stigmal band of hind wings reaching across *calatracte* D. & F.
54. All marks in the form of streaks in both wings *radiatus* R. & F.
Some spots or bands 55.
55. Spots netted; basal band of hind wings not reaching toward base; abdomen yellow with dark spots *tessellatus* R. & F.
Spots not netted; basal spot usually reaching toward base 56.
56. Four stigmal spots in hind wings *incommodus* Walk.
Two stigmal spots in hind wings; a submarginal line in both wings *immensus* McL.
57. Two stigmal bands in hind wings (or broken into spots); a submarginal row of spots *cephalotes* Klug.
But one stigmal band in hind wings 58.
58. Median band of hind wings reach across; small spots along hind border; abdomen dark, not spotted 60.
Median band not across; hind wings with many small spots; abdomen yellow, lineate with dark 59.
59. Abdomen with small spots and dots; bands of wings netted *percheroni* Guér.
Abdomen lineate, or mostly dark; spots in hind wings not netted *libelluloides* L.
60. Stigmal and median bands of hind wings connected; apical mark of hind wings entire *walkeri* var.
These bands separated 61.
61. The stigmal band of hind wings is connected or nearly so to the apical which extends along the hind border 62.
The stigmal not connected to apical, and latter not extending along the hind border; hind wings very broad in the middle *walkeri* McL.
62. Hind wings quite narrow; from North Africa *angustus* McL.
Hind wings quite broad in middle; from Madagascar *martini* Weele.

***Palpares gigas* Dalman.**

Figure—Plate XIX, Figure 17, and Drury, Pl. 41.

The fourth anal of f. w. with three or four branches and three cross-veins; the third anal in h. w. has a strong oblique vein up to second anal. Male appendages nearly twice as long as the last two segments together.

***Palpares mœstus* Hag.**

Figure—Plate XIX, Figure 15; Hagen, Mozambique paper.

The fourth anal in f. w. with four or five branches and five or more cross-veins; the third anal of h. w. practically runs into the second, and with two or three cross-veins before it. The antennae are longer than in *P. gigas*; the thorax with long white hair. Anal appendages of male, Fig. 55.

***Palpares obscuripennis* Schmidt.**

In general this resembles a very large *P. spectrum* but the fore wings are plainly tinged with pink; the pale basal part of hind wings is paler and the black has no complete pale bands, but median and stigmal pale bands reaching one-half way across wing, two spots near apex, and two to four near the hind border.

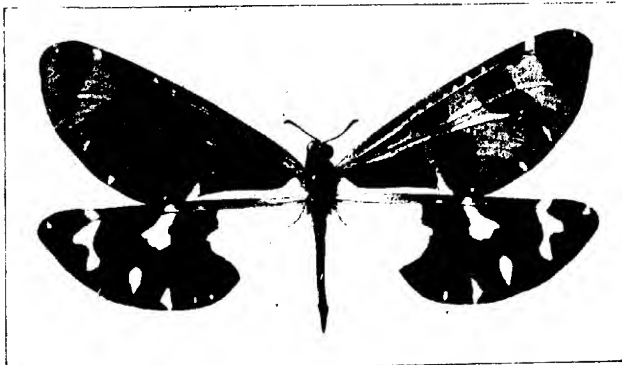


Fig. 1. *Palpares obscuripennis* Schmidt.

I have seen it only in the Stettin (type) and Berlin Museums. It may be the *P. fulvus* McLach; but I was not able to find McLachlan's type in his collection nor elsewhere.

***Palpares martini* Weele.**

Figure—Van der Weele, Madagascar, Figure 3.

This species resembles *P. walkeri*, and in that species the apical mark sometimes almost connects to the stigmal band.

Palpares cataractæ Pering.

Figure—Peringuey; and Stitz (as *obscuratus*).

Third anal in h. w. runs into the second, and is connected once or twice to the fourth anal.

This has been redescribed by Stitz as *P. inclemens* W. var. *obscuratus*.

Palpares vœltzkowi Kolbe.

Figure—Van der Weele, Madagascar, Figure 4.

A remarkable species, not only on account of the almost wholly black hind wings, but also in the very slender abdomen. Van der Weele figures (p. 255) the male appendages.

Palpares insularis McLach.

Figure—Van der Weele, Madagascar, Figure 6, also the male appendages on page 259.

Fourth anal of f. w. with three branches and one or two cross-veins to the third anal. Third anal of h. w. simple, two or three cross-veins to second, none to fourth anal. Black band below antennæ present.

P. hildebrandti is the same species.

Palpares amitinus Kolbe.

Figure—Van der Weele, Madagascar, Figure 7.

Fourth anal of fore wings long, with four branches and four or five connections to the third anal; third anal of hind wings simple, with two cross-veins to the second, none to the fourth. The legs are black; there is a large interantennal mark reaching much below the antennæ as well as above from eye to eye; the outer apical margin of the fore wings is slightly sinuated, as in several other species.

Van der Weele also figures (p. 262) the male appendages which are short like those of *P. speciosus*.

Palpares furfuraceus Ramb.

Figure—Navas (as *equestris*), Broteria, X, p. 56.

Readily known by the greatly swollen vertex and fulvous hair on thorax, which was noted by both describers. It occurs in West Africa.

Palpares sobrinus Pering.

Figure—Peringuey, 1911, p. 33, Figure 3.

I can find no differences between this species and *P. nudatus* Navas; but I have not seen the type of either species; but judge from the figures and descriptions.

Palpares nyicanus Kolbe.

Figure—Kolbe, original; and Peringuey, 1911, p. 32, Figure 1 (as *amulus*).

The third anal of h. w. runs apparently into the second, and with four or five cross-veins to the fourth anal.

P. æmulus Pering is, I think, the same species, and it is also figured by Calvert, Proc., Acad., Nat., Sci., Phil. 1899, plate X, fig. 2.

***Palpares abyssinicus* Kolbe.**

The third anal of h. w. is simple, and no cross vein to fourth.

This species is very close, if not identical, with *P. nyctanus*, the spots are arranged in oblique streaks.

***Palpares sparsus* McLach.**

Figure—Peringuey, 1911, p. 32, Figure 2.

The third anal of h. w. is simple, and no connection to fourth anal, but one to second. The fourth anal in f. w. is once or twice forked, and with two cross-veins. No band below antennæ.

***Palpares radiatus* Rambur.**

Figure—Rambur, original.

The fourth anal in f. w. with three or four branches, and two or three cross-veins; the third anal in h. w. runs into the second anal. The male appendages (Fig. 40) are curved and as long as the last segment, and enlarged a little at tip. There is no band under the antennæ.

There are but few specimens of this in European collections.

***Palpares incommodus* Walk.**

Figure—Plate XVIII, Figure 2, and by Stitz (*rubescens*) and by Navas (*astriellus*).

The third anal of h. w. appears to run into the second, two cross-veins behind to the fourth anal. In fore wings there is no line near the outer margin parallel thereto, but oblique streaks outward.

P. costatus Navas is also this same species as well as *P. rieli* and *P. rubescens* Stitz.

***Palpares latipennis* Rambur.**

Figure—Plate XVIII, Figure 1.

The fourth anal of f. w. has three or four branches and four or five cross-veins to the third anal. The third anal of h. w. is simple, with several cross-veins to the second and one or two to the fourth anal.

The *P. furfuraceus* of Walker (not of Rambur) is this species, Walker's identification of *P. cephalotes* is also this species. *P. prator* Gerst. is this species.

***Palpares inclemens* Walk.**

Figure—Plate XVIII, Figure 5.

The third anal of h. w. runs into the second anal and with one or two cross-veins to fourth. The fourth anal of f. w. has three or four branches and four cross-veins to the third.

Sometimes the basal spot of hind wings is narrowly connected to the median. The wings especially the front pair are slightly sinuated on the outer margin.

Palpares pardaloides Weele.

Figured by Van der Weele, Madagascar, Figure 5; also the male appendages on page 257.

Fourth anal of f. w. with four branches and two cross-veins; third anal of h. w. simple, no cross-vein to second. Legs deep black.

In the Brussels Museum is a long series from Madagascar that tends to connect this species to *P. insularis*.

Palpares nigrita Navas.

Figure—Plate XIX, Figure 27, and Navas, original.

Fourth anal in f. w. with two branches and two cross-veins; third anal of h. w. simple, and one straight cross-vein to the second anal. No band under antennæ.

P. languidus Navas appears also to go here, but the figure of the hind wing is broader than usual.

This is a species that stands in the Rambur collection with the label *P. manicatus* R., *P. tigris* Walk. var. *de tigris* Dalm., and also a label "Seneg." Rambur's *manicatus* according to him had two radial sectors like *tigris*, and with no locality label, so I cannot believe that this specimen is Rambur's type of *P. manicatus*. I figure the hind wing of this specimen (figure 27).

Palpares walkeri McLach.

Figure—Plate XIX, Figure 21; Navas, Broteria X, p. 35.

Fourth anal of f. w. with two or three branches, and two cross-veins; third anal of h. w. simple, three or more cross-veins to second, and one to fourth. No band under antennæ.

P. dispar Navas seems to be the same species.

Palpares angustus McLach.

Figure—Plate XVIII, Figure 7.

Fourth anal in f. w. with three branches, and four cross-veins; third anal of h. w. has an oblique cross-vein to second and two cross-veins before it. Legs all deep black; the stigmal band of the hind wings sometimes has an upper inner projection. There is no band under antennæ.

The variety *oranensis* grades into the type.

Palpares hispanus Linn.

Figure—Navas, Insecta, 1911, p. 265.

The fourth anal of f. w. has one or two short branches and two cross-veins; the third anal of h. w. is simple, with an oblique cross-vein to second, but none to fourth. The marks on the abdomen (Fig. 33) are very characteristic; as in other species there is much variation in the extent of the marks on wings, and in the width of the hind wings.

***Palpares libelluloides* Linn.**

Figure—Many figures in European literature.

The fourth anal of f. w. is very short and curved, with one or two branches and one or two cross-veins. The third anal of h. w. is simple, with slightly oblique cross-vein to the second and none to the fourth anal.

P. chrysopterus Navas is the same or a slight variety.

***Palpares tessellatus* Rbr.**

Figure—Plate XX, Figure 32 (marks of abdomen), and Stitz (as *annulatus*).

The fourth anal of f. w. has two branches, and one or two connections to the third; the third anal of h. w. is simple with one or two straight cross-veins. No dark band under the antennae.

P. annulatus Stitz is a synonym of this species.

***Palpares percheroni* Guérin.**

Figure—Guérin, Iconog. Regn. Anim., Plate 62; Gray, Anim. Kingd., Plate 127, Figure 1.

The fourth anal of f. w. has two branches and one or no connection to third; the third anal in h. w. simple, with a somewhat oblique cross-vein to second anal. The male appendages are long and curved. The abdominal marks are figured on Plate XX, Figure 31.

***Palpares tigris* Dahm. (Nosa).**

Figure—Navas (*calceata*, *leonina*, *lupina*, *pardina*, and *hamatus*).

The fourth anal of f. w. has two or three branches and two or three connections to the third; the third anal of h. w. is simple, connected twice to the second and sometimes once to the fourth.

P. manicatus Rbr. is this species according to his description. *P. hamata* is a male. *P. tigris*, *calceata*, *hamata*, *syphis* have quite large spots; *P. leonina*, *lupina* and *pardina* have smaller spots. Tip of fore wing, see figure 45.

***Palpares ægrotus* Gerst.**

Figure—Navas (as *longicornis*), Kolbe (as *submaculatus*), and Stitz (as *maculatus*).

The fourth anal of f. w. with one or two branches and two connections to the third; third anal of h. w. simple, with one cross-vein to second, none to the fourth.

Variety *laborensis* Stitz is apparently the same. Tip of the fore wing, see figure 46. *P. dilatatus* Navas has stigmal spots united into a band.

***Palpares ornatus* Navas.**

Figure—Navas (with description).

Very close to *ægrotus* and perhaps a form of it, but the apical marks are different, and these in *ægrotus* seem very constant.

Palpares speciosus Linn.

Figure—Romer, Genera, Plate XXV, Figure 3; De Geer, Mem. III, p. XXVII, Figure 9, (as *maculatus*); also Sulzer, Plate XXV, Figure 3.

The fourth anal of f. w. with two branches, and two cross-veins; the third anal of h. w. simple, with two cross-veins to second, but none to the fourth.

A peculiar variation in marking is seen on Plate XX, Fig. 37, hind wing; and male appendages Figs. 52, 53.

Palpares dubiosus Pering.

I have not seen this species nor is there any figure, but it is described as close to *P. speciosus*, so it is probably but one form of what will prove to be one common variable species.

Palpares caffer Burn.

Figure—Plate XXI, Figure 50.

The fourth anal of f. w. with two branches and two cross-veins to third; the third in h. w. simple, with one cross-vein to the second, but none to the fourth.

The difference between this and *P. speciosus* is hardly sufficient for a species, and not constant; the wings are usually shorter than in *P. speciosus*, and the fore pair less heavily marked.

Palpares varius Navas.

Figure—Navas, original description.

In fore wing the fourth anal has two branches and two connections; in hind wings the third anal is simple with two connections to second, but none to fourth.

Palpares digitatus Gerst.

Figure—Calvert, Figure 3 (unnamed); Navas (as *torridum* and *pobegidum*) and Plate XIX, Figure 21.

In fore wing the fourth anal has one branch and one cross-vein. Third anal in h. w. simple, not connected to fourth anal, with two veinlets to the second anal.

The figure I give and that of Navas represent heavily marked specimens; that of Calvert is more normal. I think *P. umbrosus* Kolbe is the same; but the bands are narrower and one or more "fingers" are usually separate from the bands, and the wings may be a little more slender, in fact it is more like *P. speciosus*, and appears to connect *speciosus* with *digitatus*. The hind wings of typical *umbrosus* are shown in figure 44.

***Palpares stuhlmanni* Kolbe.**

Figure—Kolbe, Figure 1.

Closely related to *P. speciosus*, at least in the male appendages; the marks are similar to those of *P. umbrosus*; the venation is as in *P. speciosus*.

***Palpares damarensis* McLach.**

Figure—Plate XVIII, Figure 11, and Stütz (as *bifasciatus*).

Fourth anal in f. w. with two or three branches and two cross-veins; third anal of h. w. simple, no connection to the fourth. Black hair on clypeus; legs all black; head all dark, except pale clypeus.

***Palpares formosus* Banks.**

Figure—Plate XIX, Figure 23; also Navas in Broteria X, p. 85, Figure 16.

Fourth anal in f. w. with one short branch, and one cross-vein; third anal of h. w. simple with one cross-vein to second and none to the fourth.

***Palpares festivus* Gerst.**

Figure—Peringuey (as *mosambicus*), and Navas (as *luteolus*).

The third anal of h. w. simple, and no cross-vein to the fourth. Legs black.

***Palpares elegantulus* Pering.**

Figure—Peringuey 1910, Plate VII, Figure 4.

This small slender-winged species is apparently very distinct; I have not seen it, but it appears related to the *flavofasciatus* group.

***Palpares flavofasciatus* McLach.**

Figures—Peringuey (as *genialis*); Stütz (as *guttatus*); and Navas (as *nyassensis*).

The third anal in h. w. is simple and no connection to the fourth anal. Legs black.

In *P. nyassensis* the bands are a little wider than in the other types, but a series of specimens shows much variation in this point.

***Palpares compositus* Navas.**

Figure—Navas (and also as *mistus*).

Closely related to *flavofasciatus*, but with the bands of hind wings much broader and connected. *P. mistus* Navas appears to be the same form. It is in the Berlin Museum under a manuscript name that I cannot find has ever been published.

***Palpares bifasciatus* Oliv.**

Figure—Plate XVIII, Figure 6.

Fourth anal in f. w. with two branches, and two cross-veins; the third anal of h. w. simple, connected about four times to the second and twice to the fourth. A broad black band under antennae; abdomen like yellowish red; thorax with two rows of yellow spots.

This was considered by Walker as *P. pardalinus* Burm. McLachlan doubted it, and so named Walker's insect *P. brachypterus*; but Hagen (who saw both) asserts that Walker's insect is *pardalinus* B. It agrees with the *Mymeleon bifasciatum* Olivier.

Palpares spectrum Rambur.

Figure—Navas, Rev. Zool. Afric., II, p. 37.

The fourth anal of f. w. has two branches and two connections; the third anal of h. w. is simple, with one cross-vein to second, but none to fourth anal.

Palpares rothschildi Weele.

Figure—Stütz, Figure 10.

The fourth anal in f. w. has two branches and two connections; the third anal in h. w. is simple, and one cross-vein to second anal.

Very closely related to *P. spectrum* and probably but a local variety, occurring northward of the range of *P. spectrum*.

Palpares ovampoanus Pering.

Figure—Peringuey, 1910, Plate VII, Figure 1.

This is closely related to *P. spectrum* and will fall in the subgenus *Palparellus*. I have not seen specimens in European collections.

Palpares translatus Walk.

Figure—Plate XVIII, Figure 13.

The third anal in h. w. is simple, and not connected to the fourth anal. Antennae close together at base; subcosta not thickened, but in general structure is closely related to *Pamexis luteus*.

Palpares luteus Thunberg. (*Pamexis*)

Figure—Plate XVIII, Figure 9.

The third anal in h. w. is simple, and connected once to the fourth anal.

P. venosus Burm. is the same; and Hagen asserts (and he has examined both types) that *P. conspurcatus* Burm. is also the same species. The subcosta is thickened in both sexes, otherwise the species is related to *P. translatus*. There are specimens in the Berlin, Brussels and British museums.

Palpares contaminatus Hagen.

Figure—Plate XVIII, Figure 4.

This name was given by Hagen (Can. Entom. 1887, p. 112) for *P. pardalinus* Rambur, not of Burmeister. I figure the hind wing of the type. The subcosta of fore wing is not thickened.

INDIAN SPECIES.

1. A large spot over the fork of the cubitus in the hind wing. 6.
No such spot. 2.
2. An elongate spot along middle of hind margin of hind wing; median band does not reach across. *tigroides* 3.
No such spot; median reaches across. 3.
3. Fore wings mostly dark, leaving only large and small pale spots; rather small species. *astatus* 4.
Fore wings, mostly pale, with dark bands or spots. 4.
4. Margin of fore wings plainly sinuate; some bands of both wings reach across; large species. 5.
Margin of fore wings not sinuate, bands of fore wings not across; hardly across in the hind wings. *papilionoides* 5.
5. Tips of hind wings plainly falcate; stigmal band without projection toward median band. *falcatus* 6.
Tips not falcate; stigmal spot with projection toward the tip of the median band. *contrarius* 6.
6. Two parallel stigmal bands, or spots. 7.
But one stigmal band, or broken into one series of spots. 9.
7. Both median and stigmal bands in hind wings reach across. 8.
8. Neither median nor stigmal reach across; margins of both wings narrowly dark. *astarte* 7.
Median connected to basal spot; latter reaching across hind wing. *pallens* 8.
9. Median not connected to the basal, which does not reach across. *infirmus* 9.
10. Apical mark of hind wings solid; stigma very broad and reaches across. *solidus* 10.
Apical mark with spots, or broken; stigmal band not very broad nor reaching across. 10.
10. A spot behind radius above the basal spot on the cubital fork of the hind wings; stigmal mark running obliquely inward. *zebratus* 10.
No spot behind radius; stigmal band extending outward, or curved inward. *pardus* 10.

***Palpares astarte* n. sp.**

Figure—Plate XIX, Figure 18.

Head yellowish; a row of pale hairs across clypeus, and on margin of labrum; a black spot narrowing behind on vertex, continued over thorax as a median stripe, widest on the mesothorax, dark stripe on sides of pronotum, and stripe on meso and metathorax over base of the wings; abdomen yellowish brown, a black spot on apex of the first segment; legs and sternum all black. Wings rather yellowish, and with yellowish venation; costa black, and with black points out on costals, but costals are pale; outer posterior margin of both pairs of wings dark brown; fore wings with five series of spots; a long streak on cubitus broader at tip and bending down; a spot above it behind the radius; an oblique band beyond the streak reaching from radius to more than one-half way across; beyond this are two spots in an oblique row; then three spots in a transverse row, one stigmal, the other two in form of streaks; the two subapical marks are not quite streaks. In hind wings is a spot on cubital fork, a band beyond reaching to beyond middle where it is enlarged; a curved band beyond this, not reaching either radius or hind margin, larger behind; then two large spots, one stigmal, the other close behind it; then a sinuous band before apex. Wings of moderate breadth; in fore wing the third anal is connected to the fourth four or five times, in hind wings the third anal has an oblique vein running into the second anal, and one cross-vein beyond it. Expanse 125 mm.

From Chapra, Bengal, India (Mackenzie).

Palpares pardus Rambr.

Figure—Plate XVIII, Figure 3, and anal appendages, Plate XXI, Figure 54.
The fourth anal of f. w. has three or four branches and three cross-veins; the third anal in h. w. is simple, with two cross-veins to second.

P. expertus Walk is the same species; it is very common in India.

Palpares zebratus Rambr.

Figure, Plate XX, Figure 28.

The third anal of h. w. simple, with two to four cross-veins to second and one to three to fourth anal. Abdomen with a median dark stripe above. The fore wings are without distinct bands, but with median and stigmal spots.

Palpares contrarius Walk.

Figure—Plate XVIII, Figure 8.

The third anal of h. w. simple, with two cross-veins to the second, one of which is slightly oblique, in the f. w. the fourth anal has two branches and two or three connections.

This is a beautiful species not uncommon in Ceylon. In Walker's description a line is omitted regarding the second band in the hind wings, for it is this band that has a projection toward the first band.

Palpares falcatus McLach.

Allied to *contrarius* in markings, but hind wings more falcate; I have seen only the type.

Palpares patiens Walk.

Figure—Plate XVIII, Figure 10, and Navas in Broteria X, p. 86, Figure 17.

The third anal of h. w. runs into the second, and a cross-vein behind to fourth anal; abdomen dark, unmarked.

Palpares infirmus Walk.

Figure—Plate XVIII, Figure 12.

The third anal of h. w. with an oblique vein to the second, one cross-vein before it to second, and one behind to fourth anal. No band under antennæ.

This is probably the same species as *P. patiens*. Fore wings with many spots, and streaks and spots along the outer hind margin, stigmal and median bands small.

Palpares papilionoides Klug.

Figure—Klug, Plate, Figure 2.

The third anal in h. w. is simple, no cross-vein before the oblique one running into second.

It is not common and is represented in but few European collections.

***Palpares solidus* Gerst.**

Figure—Plate XIX, Figure 20; and Navas (as *klapaleki*).

The fourth anal in f. w. is two or three branched, and with two or three connections; the third anal in h. w. is simple, with one cross-vein to second.

***Palpares tigroides* Walk.**

Figure—Plate XX, Figure 34.

Third anal of h. w. simple, one cross-vein to the second and none to fourth anal. Legs black; fore wings with hardly any marks, rather yellowish.

***Palpares astutus* Walk.**

Figure—Plate XIX, Figure 19.

The fourth anal of f. w. with two branches, and two cross-veins; the third anal of h. w. simple, with one cross-vein to second. It belongs to the subgenus *Palparellus*.

STENARES.

(including *Crambomorphus*.)

- Outer margin of wings strongly sinuate.....(*Crambomorphus*) 2.
- Outer margin of wings not plainly sinuate.....(*Stenares*) 3.
- Hind wings pale with two large bands well separated, and apex marked.....
grandidieri Weele.
Hind wings with the bands so large they are connected and cover most of surface, leaving only pale spots.....*sinuatus* Oliv.
- Hind wings with all the bands broad and connected, leaving only pale spots.....
madagascariensis.
Hind wings not so heavily marked..... 4.
- No stigmal spot in hind-wings, a streak along outer edge, and sometimes a few dots before it; wings very narrow; in hind wings costals at base are crossed.....
hyaena.
- A stigmal spot reaching nearly one-half way across..... 5.
- A spot on hind wings just beyond the cubital fork, also large median band; wings broad; in hind wings the costals are mostly simple.....*irroratus*.
No spot on hind wings near the cubital fork, but median spot (or band) are sometimes present; in the hind wings the costals are mostly crossed..... 6.
- Larger; apical mark of the hind wings in the form of two streaks.....*improbatus*.
Smaller; apical mark of the hind wings entire, or partly broken, not in form of streaks.....*harpyia*.

In *S. hyaena*, *irroratus*, *improbatus* and *harpyia* the third anal of h. w. runs into the second, with one or three cross-veins before; all have a pale pronotum with a median black stripe, and all have black legs.

***Stenares (Crambomorphus) grandidieri* Weele.**

Figure—Weele, Madagascar, Fig. 2.

Differs much in markings from *S. sinuatus*; fully half of the hind wing is hyaline; the wings are also much broader than in that species, but the hind wing shows the same costal swelling at apex. The anal venation is similar to that of *S. sinuatus*, but in the h. w. the third anal has but one cross-vein to the fourth anal.

Stenares (Crambomorphus) sinuatus Oliv.

Figure—Plate XIX, Fig. 14.

Hind wings black; two pale spots in middle and stigma pale, and pale spots on hind border.

Fourth anal in f. w. has four branches and four connections; in h. w. the third anal is long, with an oblique cross-vein to the second, and others nearly erect, and four cross-veins to the fourth anal.

Palpares hæmatogaster Gerst. is the same species.

Stenares irroratus Navas.

Figure—Navas, original.

I have seen only the type in the British Museum.

Stenares improbus Walk.

Figure—Plate XIX, Figure 16, and male appendages, Figure 25.

In h. w. the third anal runs into the second, and has two cross-veins to fourth; in f. w. the fourth anal has five branches and five cross-veins to the third.

Stenares harpyia Gerst.

Figure—(Anal appendages) Plate XIX, Fig. 26.

The fourth anal of f. w. has many branches and many connections to the third anal; in h. w. the third anal runs into the second, and has two branches.

Stenares madagascariensis Weele.

Figure—Van der Weele, Madagascar, Fig. 1.

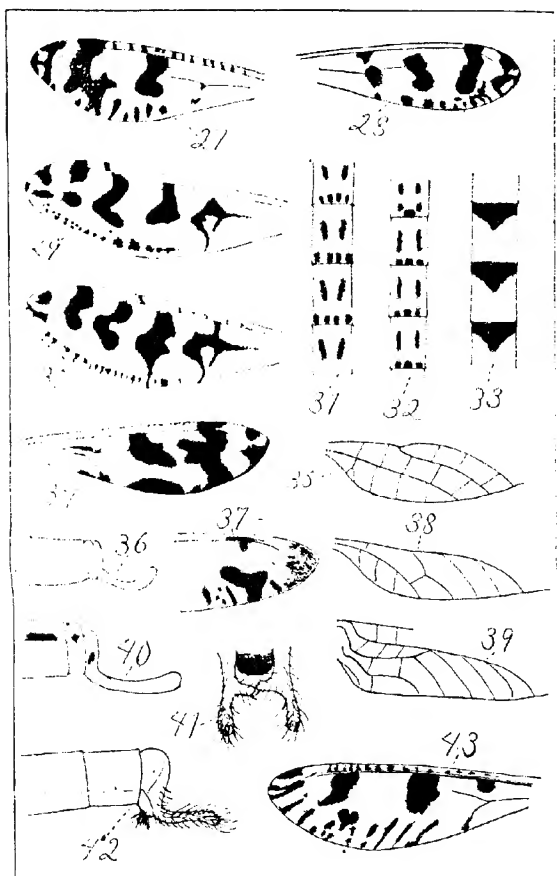
The third anal of hind wing is simple, with an oblique cross-vein to second and two or three before it, and four or five cross-veins to the fourth.

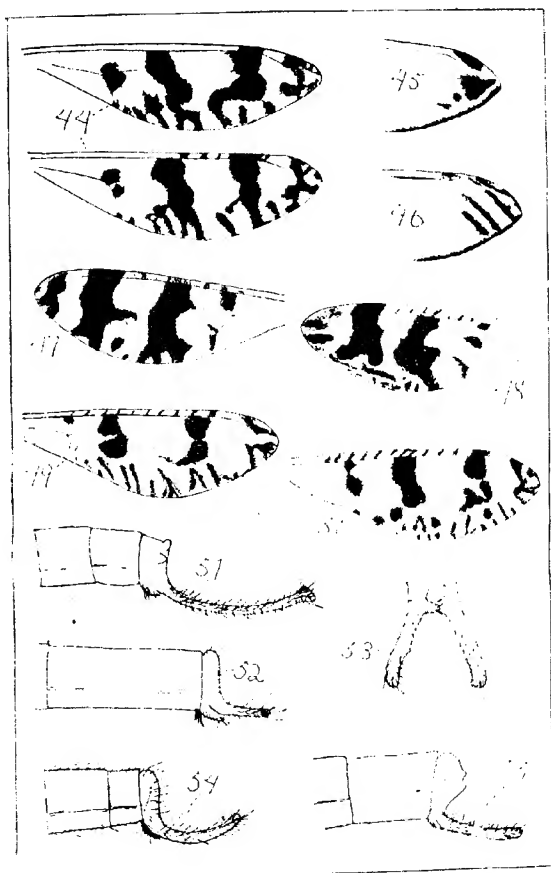
Stenares hyæna Dalman.

Hagen considers the figure 12, plate 86, of the Fourth volume of Seba's Thesaurus as representing the species.

EXPLANATION OF PLATES XVIII TO XXI.

- Fig. 1. *Palpares latipennis*, hind wing.
 Fig. 2. *Palpares incommodus*, hind wing.
 Fig. 3. *Palpares pardus*, hind wing.
 Fig. 4. *Palpares contaminatus*, hind wing.
 Fig. 5. *Palpares inclemens*, hind wing.
 Fig. 6. *Palpares bifasciatus*, hind wing.
 Fig. 7. *Palpares angustus*, hind wing.
 Fig. 8. *Palpares contrarius*, hind wing.
 Fig. 9. *Pamexis luteus*, hind wing.
 Fig. 10. *Palpares patiens*, hind wing.
 Fig. 11. *Palpares damarensis*, hind wing.
 Fig. 12. *Palpares infirmus*, hind wing.
 Fig. 13. *Palpares translatus*, hind wing.
 Fig. 14. *Stenares sinuatus*, hind wing.
 Fig. 15. *Palpares moestus*, apex of hind wing.
 Fig. 16. *Stenares improbus*, hind wing.
 Fig. 17. *Palpares gigas*, apex of hind wing.
 Fig. 18. *Palpares astarte*, fore and hind wings.
 Fig. 19. *Palpares astutus*, fore and hind wings.
 Fig. 20. *Palpares solidus*, hind wing.
 Fig. 21. *Palpares walkeri*, hind wing.
 Fig. 22. *Palpares immensus*, hind wing.
 Fig. 23. *Palpares formosus*, hind wing.
 Fig. 24. *Palpares digitatus*, hind wing.
 Fig. 25. *Stenares improbus*, male appendage.
 Fig. 26. *Stenares harpyia*, male appendage.
 Fig. 27. *Palpares nigrita*, hind wing.
 Fig. 28. *Palpares zebratus*, hind wing.
 Fig. 29. *Palpares subduccens*, hind wing.
 Fig. 30. *Palpares sollicitus*, hind wing.
 Fig. 31. *Palpares pereheroni*, abdomen.
 Fig. 32. *Palpares tessellatus*, abdomen.
 Fig. 33. *Palpares hispanus*, abdomen.
 Fig. 34. *Palpares tigris*, hind wing.
 Fig. 35. *Palpares latipennis*, anal and antinotus, anal area of fore wings.
 Fig. 36. *Palpares lentus*, male appendages.
 Fig. 37. *Palpares speciosus*, variation of hind wing.
 Fig. 38. *Palpares insularis*, anal area, fore wing.
 Fig. 39. *Palpares inclemens*, anal area, hind wing.
 Fig. 40. *Palpares radiatus*, male appendages.
 Fig. 41. *Palpares umbrosus*, male appendages.
 Fig. 42. *Palpares immensus*, male appendages.
 Fig. 43. *Palpares obsoletus*, hind wing.
 Fig. 44. *Palpares umbrosus*, hind wings of two males.
 Fig. 45. *Palpares tigris*, apex of fore wing.
 Fig. 46. *Palpares agrotus*, tip of fore wing.
 Fig. 47. *Palpares lentus*, hind wing.
 Fig. 48. *Palpares extensus*, hind wing.
 Fig. 49. *Palpares interioris*, hind wing.
 Fig. 50. *Palpares caffer*, hind wing.
 Fig. 51. *Palpares tristis*, male appendage.
 Fig. 52. *Palpares speciosus*, male appendage, side.
 Fig. 53. *Palpares speciosus*, male appendage, above.
 Fig. 54. *Palpares pardus*, male appendage.
 Fig. 55. *Palpares moestus*, male appendage.





STOMOXYS CALCITRANS LINN, PART II.*

By CHAS. K. BRAIN.

The Circulatory System.

The circulatory system in *Stomoxys calcitrans* consists, as in other Diptera, of the dorsal vessel or heart and its anterior continuation, the thoracic aorta. The dorsal vessel extends as a delicate tube from the posterior part of the abdomen to its anterior sixth, that is above the anterior part of the sucking stomach, where it becomes narrowed into the thoracic aorta. This narrowed portion continues of uniform thickness until the proventriculus is reached, where it becomes somewhat flattened and wider. Beyond this it becomes narrower, and terminates above the esophagus, between the proventriculus and the neck.

It may be noticed that, as found by Professor Minchin in his study of *Glossina* sp., the dorsal vessel ends blindly behind, is composed of similar giant cells, and has similar ostia and alary muscles. The number of chambers in the heart was not determined with certainty, but I think Tulloch was correct in supposing that there were four. The dorsal vessel lies free in the pericardial cavity, but is supported by the muscular pericardial septum.

Nervous System.

There are two chief ganglia, viz: the brain and the thoracic ganglion, and from these the main nerve-trunks arise. Time was not taken to work out the more minute nerves, but the following may be mentioned. The chief nerves of the head beyond those of the compound eyes, are those which enervate (a) the antennae, (b) the ocelli, and (c) the esophagus, pharynx, and the pharyngeal muscles.

The brain is connected with the thoracic ganglion by commissures, between which the esophagus passes. The thoracic ganglion is roughly pear-shaped, and is supported by the internal chitinous skeleton of the thorax. The main nerves given off from the thoracic ganglion are (a) six pairs which

*The first part of this paper, which dealt with the external mouthparts and the digestive system, appeared in Vol. V, No. 4, pp. 421-430 of these ANNALS, December, 1912.

supply the thoracic muscles, and (b) the abdominal nerve trunk, which arises as a stout continuation of the posterior part of the ganglion. This nerve trunk gives off fine branches to the abdominal muscles and on reaching the third abdominal segment, splits into three.

These three branches supply the reproductive organs, the ovaries or testes, and the ovipositor or the penis.

Reproductive System.

The male generative organs, (Plate XXII, Fig. 7.) are comparatively simple in structure. They are however not readily seen in gross dissection until some of the surrounding and over-lying Malpighian tubules are moved. They consist of a penis, ejaculatory duct, vesicula seminalis, and testes with their ducts.

The testes are smooth, spherical bodies, enclosed in sacs which have deeply pigmented walls, giving them a deep orange color. From the lower end of each testis a delicate tube arises, short and straight, which runs down to join the duct from the opposite side, as the upper limbs of a Y.

From this junction an exceedingly short length of common duct enters the bulbous upper end of the tubular organ, which would seem to serve as a vesicula seminalis. This is a flexible tube, often seen lying with one or two U-shaped bends in its course. At its upper end this vesicula seminalis is bulbous, gradually narrowing below to form the ejaculatory duct, (Fig. 7, e. d.), which crosses the rectum dorsally from left to right, to enter the penis in front of it.

The female reproductive organs, (Pl. XXII, Fig. 8) are of the house fly type. There are two ovaries, each consisting of some 60 ovarioles. The ovaries vary in size according to the degree of maturity of the lowest ova, of which there are never more than four in a single ovariole. In some cases the ovaries occupy more than half of the whole abdominal space. The ovarioles from one side open into a wide tubular duct which joins the similar duct from the other side like the arms of a Y.

As a result of this junction a common oviduct (o. v.) results, which runs down forming a long third limb to the Y. Below the attachment of the uterine appendages the oviduct continues as the uterus. The appendages consist of the uterine glands and the receptacula seminis.

The uterine glands, (u. g.), are two rather stout tubular organs with slightly bulbous extremities. The bulbous end is firmly joined to the lateral oviduct by a very short double strand of connective tissue.

The receptacula seminis are two small, black, spherical bodies, each with a cellular socket resembling the fitting of an acorn cup. From this runs a very fine duct which enters the division between the oviduct and the uterus in the mid-dorsal line. The receptacula are attached to each other but can be separated by dissection. The uterus is a tube of the same diameter as the common oviduct above, and runs down the middle line into the ovipositor.

The ovipositor consists of three cylindrical segments of thin chitin which usually lie telescoped inside the abdomen.

Habitat.

Farmyards and stables are evidently the favorite haunts of this fly. It occurs also in fields and open woods, especially where cattle or horses are grazing. It is evidently by no means uncommon even in large cities, and numbers have been seen in quite busy streets. It is fond of resting on surfaces fully exposed to the sun, such as doors, gates, and rails, and to a less extent also on stone walls. Painted surfaces seem to be specially attractive to it. Its flight is quite inaudible at a short distance. When disturbed it frequently returns to the same spot, as though it were a favorite resting place. It is quite active during the warmer part of the day, and at night returns to some sheltered spot such as the beams in a shed. In Columbus the numbers of this species dwindled towards the end of October in 1912, but a few could be caught up to the end of November, and four specimens were taken on December 3rd. In captivity these flies live but a short time, generally less than a week. They frequently clean their wings, performing their cleaning with great precision, the hind pair of legs being used for this purpose. The lower surface is combed, then the upper, the legs are then rubbed together and the process repeated.

Emergence from the egg.

The larva makes its escape from the egg by splitting the broad end of the groove, leaving it slightly raised, and apparently intact on the opposite side, Plate XXII, Figure 1.

The Larva. Plate XXII, Figs. 2 and 3.

Color creamy white to yellowish, shiny, greasy in appearance. The coiled alimentary tract, when filled with food, gives the posterior portion a dark appearance. The longitudinal tracheae may be recognized as two submedian white lines which show delicate lateral branches. The posterior stigmata are black, while the thoracic ones are yellowish in color.

In form the larva is elongate, tapering towards the head but broadly rounded behind. The segmentation is not very conspicuous, and the epidermis is bare, not having hairs nor bristles. On the head may be seen two large divergent maniform processes, at the end of which are the minute retractile antennae, which are apparently each composed of four subequal segments. The mouth parts are strongly chitinised in the full grown larva and are composed of a number of sclerites as shown in Figs. 2 and 3.

The last seven segments are furnished, on their ventral surface, with raised bands of tactile tubercles. The posterior stigmata are two in number, circular, and somewhat distant from each other. The thoracic stigmata occupy a sub-lateral position on the third segment, and each consists of five circular orifices. (t. s.). These are connected with a large bilateral air sac which extends along the fourth segment.

Method of pupation.

The time taken for pupation is usually about two hours. The larva at first becomes quiet, and shortens rapidly, chiefly by the contraction of the anterior segments. In this way it assumes a form which resembles a barrel in shape. At this stage it is still yellowish white and the mouthparts of the larva are plainly visible through the soft integument. The color then changes to a bright yellow, and in about an hour longer it assumes the normal chestnut color of the puparium.

The puparium is from 5 to 6 mm. in length, only eleven segments are visible, the anterior one bearing the minute, bilateral, thoracic stigmata, while the broadly rounded posterior segment shows the disc-like posterior stigmata. Under optimum conditions this stage lasts from 9 to 13 days.

Development of the adult.

About three days before the emergence of the adult fly, the cuticle of the puparium darkens, and eventually splits along the lateral and median lines, anteriorly, and trans-

versely across the fourth segment. This section falls away and the fly escapes. Prior to this the nymph undergoes its final ecdysis, pushing its effete skin off backwards into the posterior end of the puparium. On its emergence it appears as a small dark fly, gray in color, with thick rudimentary wings of a dull leaden color. Its head is, at this stage, much wider than the thorax, and the abdomen is attenuated. At first it is very active, the period of activity evidently serving to allow the fly to force its way to the surface before the wings are fully grown and stiffened. The frontal sac is constantly inflated during this time, and no doubt serves in moving fragments of earth, etc. out of the way. When liberated the insect spends considerable amount of time in combing out the hairs on the arista of the antennae.

During this time the fly constantly changes its position, and the frontal sac is contracted. There are marked changes, too, in the abdomen and wings. The abdomen first becomes longer, and is constantly expanded and contracted, and gradually assumes its normal coloring, with the clove spots. The wings then begin to expand, a process which is completed in less than five minutes.

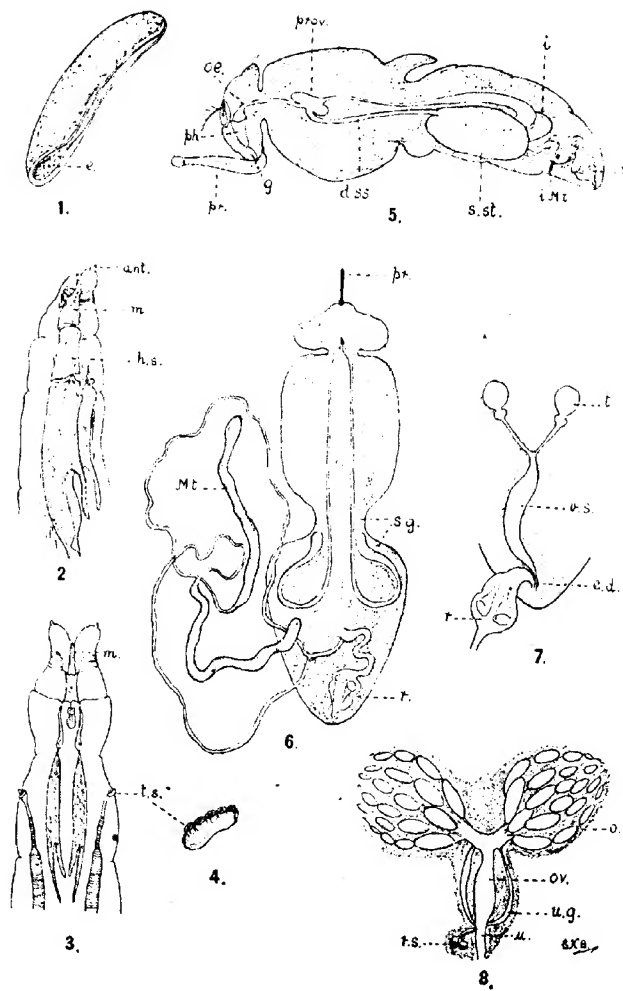
The fly is about its normal size, shape, and color at this time, but some time is taken in the final hardening of the integument, and in the final combing operations, which seem to be indispensable before flight. It is during this last process that the proboscis is at last raised into its horizontal position.

REFERENCES.

- See Bibliography given in Part I, and also:
 NEWSTEAD, R. 1907. *Stomoxys calcitrans* Linn. Ann. Trop. Med. and Parasit. Vol. I. 1907. Liverpool.

DESCRIPTION OF PLATE XXII.

- FIG. 1. Egg, greatly enlarged, showing groove, and point of emergence of the larva, *e*.
 FIG. 2. Lateral view of anterior segments of larva, showing *ant*, antenna; *m*, mandible; *h. s.*, hypostomal sclerite.
 FIG. 3. Dorsal view of anterior segments of larva of *Stomoxys calcitrans*. *m*, mandible; *t. s.*, thoracic spiracle.
 FIG. 4. Openings of thoracic spiracle.
 FIGS. 1, 2, 3 and 4. After Newstead.
 FIG. 5. Semi-diagrammatic view of adult fly. See Part I.
 FIG. 6. Salivary glands and left Malpighian tube of adult, see Part I.
 FIG. 7. Male reproductive organs: *t*, testis; *v. s.*, vesicula seminalis; *e. d.*, ejaculatory duct; *r*, rectum.
 FIG. 8. Female reproductive organs: *o*, ovary; *ov*, oviduct; *u. g.*, uterine gland; *u*, uterus; *r. s.*, receptacula seminis.



THE BIOLOGY OF PERLA IMMARGINATA SAY.*

By LUCY WRIGHT SMITH.

Introduction. Perhaps less is known concerning the life-histories and habits of the Plecoptera than of any other group of aquatic insects. Hence a more extensive knowledge of stone-flies along biological lines is desirable. At the suggestion of Professor James G. Needham such a study was commenced at Ithaca in the fall of 1910.

This locality with its many creeks and spring brooks is an excellent collecting ground for Plecoptera, and the equipment of the limnological laboratory of Cornell University makes an intensive study of aquatic forms possible. The essential factor in rearing stone-flies, as in many other stream-inhabiting insects, is running water. This is provided by a series of taps in a roof garden aquarium and also in a small artificial pond out of doors.

Methods. With the hope of obtaining truer results by keeping conditions as natural as possible, most of this study is being carried on out-doors. Some care must be taken in transporting stone-fly nymphs from the stream to permanent quarters. Full grown nymphs can breathe air directly, and have been carried most successfully wrapped in a wet cloth or packed in damp moss. Smaller nymphs can be taken safely for short distances in collecting jars full of clean, cold water.

In the artificial pond the nymphs are kept, eight to ten together, in cylindrical cages made of galvanized wire screen with cheese cloth covers. For small nymphs it is necessary to have the lower part of the cage lined with cloth. The cages are partially submerged in the current near the taps. With flat stones and bits of water weed in the bottom, and a steady flow of water, the nymphs can live a natural life.

The shyness of adult stone-flies makes field observations at close range impossible. Consequently they are kept in screen cages of about two by three feet. Here again an imitation of natural environment is attempted. This is done by keeping straw twigs, clumps of sod, stones and pans of water in the cages.

*Contribution from the Limnological Laboratory of Cornell University.

Although these pans of water are but a poor imitation of streams they suffice for most purposes. Better aerated water is necessary, however, for development of eggs. For this reason they are kept in running water in test-tubes closed at either end with fine silk bolting-cloth.

Nymph.

Habitat. This introductory paper includes only the observations made in June, July and August of the past summer, upon a single species, *Perla immarginata*. The nymphs occur in moderate numbers in all the larger streams about Ithaca, and very abundantly in the spring brook at Coy Glen. This abundance may be accounted for by the fact that there is less competition for a livelihood in this stream. *Perla immarginata* reigns supreme at the height of its season, the middle of July, not only as the largest of the stone-flies, but of all the aquatic insects. In the other streams are several competitors of equal size and strength and many more enemies.

Early in the spring, torrents of water rush through the glen, but in July and August the brook is reduced to a shallow stream. The high walls and the narrow, winding course of the gorge shut out so much sun-light that in spite of its shallowness, the water is always cold. Much of the stream bed is shale, free from sand and gravel, but well covered with a diatomaceous ooze. Here the water flows in a thin sheet. In other places are deeper pools strewn with clean, coarse gravel. Stones of all shapes and sizes are scattered along the stream. At this season, most of the stones, even the flat ones on the rocky bed, are partly out of water. Generally these are the haunts of stone-fly nymphs just before emergence.

Neighbors and enemies. These same stones shelter other creatures, fragile may-fly nymphs, chironomid larvae partially concealed in their slime tubes, and caddis worms standing guard behind their seines. Nearby on the rough floor of the stream hang the last stragglers of the mats of black fly larvae. In crevices on all sides lurk cray-fish, less welcome neighbors.

Occurrence. Late in June an occasional sprawling, nymphal skin clinging to the upper surface of a stone fortells the approach of the season for *Perla immarginata*. About three weeks later the casts are very numerous, and the overturning of a single stone sends a whole colony of the tiger-striped nymphs scampering in all directions in search of hiding places.

Length of Nymphal Life. It is evident at a glance that these nymphs are not all of the same size or stage of development. They fall into three groups. One contains very few individuals, these are small immature nymphs not more than half an inch in length. The second group, also a small one, is made up of nymphs about three quarters of an inch long. These are immature too, but older than first, larger and with small wing pads. The mature nymphs with their black wing pads form the largest group.

As far as is known, the complete life-history of no stone-fly has been worked out. Therefore we can only speculate concerning the length of it, knowing of course that whatever it may be, by far the greater part is spent in the nymphal stage. From the brief period of incubation of the eggs of some of the smaller individuals of the group, *Capnia* for example, and from the appearance of mature nymphs only at the emerging season, it seems probable that the life-history of these is completed in a year. On the other hand, the three groups of nymphs of different size in *Perla immarginata* and allied species, seem to indicate, as in some of the larger may-flies, a longer period, probably three years. Just where the nymphs live when it is not the transformation season, is not known.

Adaptations. A closer examination of the mature nymph shows that there are no external sexual characters. Nevertheless, the females can be easily separated from the males because the dark brown eggs show through the sides of the abdomen. In addition, as one would expect, the males are smaller; they vary from three quarters of an inch to an inch in length. The females have the same degree of variation, the largest being about an inch and a quarter in length and the smallest a little less than an inch. The color pattern of the nymph, black banded with white or pale yellow, and snowy white tufts of the tracheal gills on the thorax behind and above each leg, would make them rather conspicuous if they lived in the open. (Figs. 3 and 4).

The form of the nymph—flat-bodied, with flat, sprawling legs, and tarsi armed with two strong claws—is strikingly adapted for clinging. The legs are fringed with long hairs, which make them useful in swimming as well as running, and one need only disturb the nymphs to see how swiftly they can escape by either method. The shyness of stone-fly nymphs, their splendid

adaptations for clinging, running and swimming make their existence fairly easy, especially in this stream where the crayfish is the only enemy of any account.

Food Habits. The long standing supposition that stone-fly nymphs devour their weaker neighbors, has been confirmed for this species in a study of their food habits. This has been done by examining the stomach content of nymphs taken from the stream, and also by feeding those in captivity. Dissections of mature nymphs show the alimentary canals empty and in many cases even so collapsed that they are difficult to find at all. Likewise the nymphs kept for rearing refused all food for eight or ten days before transformation.

With growing nymphs it is different; here it is a task to supply them with enough food to prevent their eating one another. In a single day three or four of these nymphs will dispose of a score or more black-fly larvae and half as many small may-fly nymphs. Their greed is brought out even more strikingly by examining the food mounts of nymphs taken from the stream: whole specimens of midge larvae are found not uncommonly and sometimes a may-fly nymph with even the gills intact. The mass of food, however, consists of innumerable shapeless scraps of chitin with scattered fragments of abdomens, setae, antennae, legs; or claws, whole heads, mandibles, maxillae, and labia, making possible the recognition of may-fly and stone-fly nymphs, midge and simuliid larvae and pupae.

The only evidence of any herbivorous tendency in this species is the presence of an immense number of diatoms in food mounts. Of course this is a question of direct or indirect eating. One would expect to find diatoms in a food mount made up of pieces of may-fly nymphs and chironomid larvae, and the natural supposition might be that the stone-fly got them second hand. Yet such a statement cannot be made without some hesitation, because the number of diatoms in the mounts seems to increase with a general decrease in the amount of food; and also because diatoms have been found to be the chief food of some of the smaller species of stone-flies.

Transformation. Just before the time of transformation when the nymphs cease eating they become sluggish. And as the time approaches they crawl further and further toward the surface of the water, and finally entirely out of it where they often remain for hours before emergence. The actual

casting of the skin has not been seen in this species. Although adults are rarely absolutely perfect specimens, the percent of individuals lost by inability to complete transformation is exceedingly small. Judging from the fact that no newly emerged insects have been found, it is thought that they must transform during the night, or more probably, in the early hours of the morning.

Adults.

Characteristics. The adult *Perla immarginata*, (Fig. 5), is uniformly dull brown and much less conspicuous than the nymph. As soon as the insect loses its tracheal gills and gains four well developed wings, it is ready for aerial life. Unlike many adults with this equipment, some of the nymphal tendencies are carried over into this stage. Chief among these is the love for hiding. So great is their shyness that, even at the height of the emerging season, the adults are rarely found in the field. Repeated attempts at sweeping the foliage along the stream have met with little success. Careful searching of the rocky walls of the gorge has occasionally revealed an adult hidden away in a crack or crevice. Similar habits have been noticed in the adults kept in cages. They never rest on the twigs but crawl into hiding under the edge of the stones, or trees, or wherever they can wedge themselves into a tight place.

Although they avoid day-light, artificial lights attract them at night. They have been found crawling along poles and fences, or in the road under electric lights in the neighborhood of streams.

When disturbed the adults rarely seek escape by flight, but usually by running. Here again we see a nymphal trait, and a characteristic of the group. They are poor flyers and dependent upon their legs. Some stone-flies do not fly at all, although provided with fully developed wings.

Food Habits. A striking difference between the nymph and adult is found in the structure of the mouth and in the food habits. A character long assigned to stone-flies is rudimentary mouth parts of a biting type. This is true for *Perla immarginata*, but not for the entire order. In this species we have the reduction of the strong chitinous mandibles to three fleshy lobes, (Fig. 1). The very appearance of such an apparatus indicates its uselessness, and examination of the

alimentary canal of adults taken in the field, has confirmed this. Water seems much more essential than food for these adults. If ever found out of hiding in their cages, they were almost sure to be on the stones in the pans with their mouths buried in water. Entirely deprived of water, the average length of life is shortened by several days.



FIG. 1.

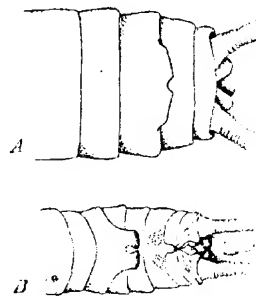


FIG. 2.

FIG. 1.

- a. Left mandible of the nymph, inner surface.
- b. Left mandible of the adult, same view and magnification.

FIG. 2.

- a. Abdomen of the female, ventral view showing the modification of the sternites.
- b. Abdomen of the male, dorsal view showing the genital armature with penis extruded.

Both figures drawn to the same scale.

The voraciousness of the nymphs is necessary, since the adults abstain from food and since enough energy must be stored up to last through aerial life and the completion of the final function, reproduction.

Mating. Ordinarily mating begins soon after emergence. The readiness with which it takes place in captivity has been a great surprise on account of the natural timidity of stone-flies. Frequently pairs have been found in copula in the breeding cages and have been removed to adult quarters without arousing enough alarm to cause their separation. By careful manipulation copulating pairs can even be held in the palm of the hand. This has made a detailed study of mating possible.

Difference in size and external sexual characters make distinguishing the sexes easy. The smallest males measure not more than an inch to the tip of the wings, and the greatest measurement for a female is one and three-fourths inches. In the female the posterior border of the eighth sternite is thickened and slightly emarginate in the middle, (Fig. 2, A). The external sexual appendages of the male, although hidden by the wings, are much more prominent. The fifth tergite is prolonged in the form of a fork extending over the sixth and most of the seventh tergites. The tip of this meets a groove running through the mid dorsal line on the eighth, and surrounded on either side by papillose prominences. The ninth segment is shortened, and the tenth is slightly elongate ending in two strong recurved hooks, (Fig. 2, B).

Just how such an apparatus operated was not obvious at first or even second glance, in fact not until copulation was actually seen. The male rests upon the female grasping her wings and abdomen with the legs of one side, and supporting himself with the legs of the other side. Then bending the end of the abdomen around that of the female, and arching it forward, the male presses close against the female and pulls down the lamina, forcing the recurved hooks up into the vagina. After a few seconds, the male starts a slightly rhythmic motion by alternately pulling to and fro. As the motion becomes quicker, the hooks are gradually withdrawn, and there is exposed between them a white, fleshy penis resting in the groove and supported toward the tip, by the fork on the fifth tergite. This rhythmic motion seems to be pump-like in action. With a quick jerk the recurved hooks are brought up against the fork, an act which causes the contraction of the penis and forces the seminal fluid up into the vagina. The expansion is slower, allowing the penis to become refilled. Undisturbed, copulation usually lasts about forty-five or fifty minutes. Except for microscopic horny papillae on the tip, the penis is entirely fleshy and composed of two telescopic segments. After copulation, it is gradually retracted into the body just below the anal opening, and entirely hidden inside.

Egg-laying. As is commonly known, stone-flies do not deposit their eggs directly, but carry them around for a time in a tube at the end of the abdomen. It is hard to see the reason for this. Apparently it is not to be found in the condition of

the egg itself, for there seems to be no difference between eggs just extruded and those carried for a couple of hours, half a day, or longer. There is a constant regularity in the length of time that elapses between copulation and extrusion of eggs, but not in the length of time eggs are carried. Individuals in the same cage eventually deposit their eggs in the same place, but one may carry them two hours, and another nearly a day under exactly the same conditions.

I am in doubt as to the normal method of depositing eggs. In the field, smaller species, carrying eggs, are often seen on the stones in streams as if they were about to crawl down to the water. And again they appear flying low along the stream and dipping to the surface as if ovipositing. No such observations have been made upon the larger species. The few adults of *Perla immarginata* which have been seen dropping their eggs in the pans seemed to do it more from accident than from intention. They were crawling around the stones and had floundered into the water. The instant they came in contact with the water the eggs dropped to the bottom of the pan. But many masses of eggs have been found in the pans too far from the edge, or from the stones, for them to have been dropped except from above, or by the individuals having actually crawled into, or on the water.

Concerning the place where the eggs are deposited there is no doubt. When the globular mass touches the water the eggs begin to separate. In the pans they finally settle down into a patch one layer deep, (Fig. 6). Of course this is not the case in the streams where the current scatters them broadcast. They are not tossed about long, however, for as soon as they come in contact with any object they become attached by the glutinous cap which surrounds the micropylar apparatus. These eggs are about half a millimeter long, dark brown in color and oval-shaped. Except for a single circular ridge the chorion is without ornamentation, (Fig. 7).

In following the movement of the different adults from day to day it was necessary to have some means of identifying them as individuals. As has been previously stated, an absolutely perfect adult is rare. Consequently it was a very simple matter to recognize individuals on such characters as a broken antenna or seta, a tarsus minus a segment or two, an imperfect wing, and so on. In this way during the season thirty-two

females and twelve males were kept under close observation. It was soon found that all the eggs were not deposited at one time. A few hours after the first mass was laid, mating occurred again, and within twenty-four hours a second lot had been deposited. Often there was a third mass, and in a few instances a fourth. These followed less rapidly.

As one would expect each successive mass was smaller than the one preceding. A thousand eggs is ample average for a first mass and four masses together would not total over sixteen hundred. It seems likely that a large number of eggs must reach the hatching stage. The chances of fertilization are good since copulation occurs more than once, also if one mass has fallen in an unfavorable place there is a possibility that the others have met with better luck. Yet the number of individuals which reach maturity is comparatively small. A great loss probably occurs during the early nymphal stage when the small white nymphs would be dainty morsels for many a larger creature.

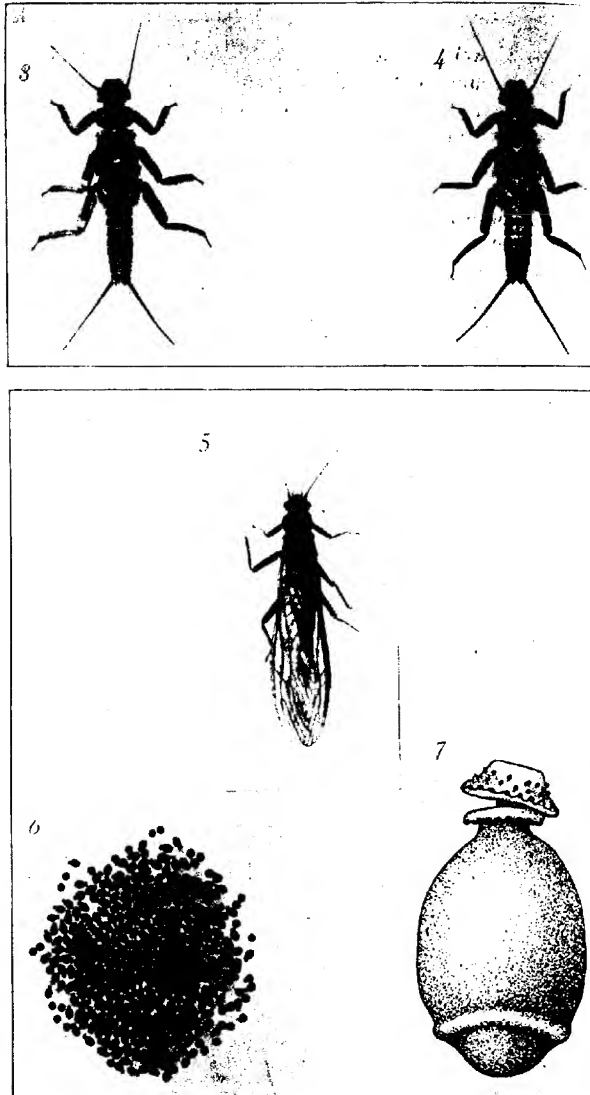
Mating has the usual effect upon the length of life of the adults. When males and females are caged together the average female dies after six or seven days and the male after nine or ten. On the other hand if the sexes are kept apart they live twelve or thirteen days.

Only a small proportion of the eggs laid in captivity were kept for development. These were easily loosened from the pan with a pipette, removed to the glass tubes and put into running water. They have not yet hatched.

Ordinarily the one great difficulty which has stood out above all others, in attempting to get a complete life history of a stone-fly has been in the handling of the very young nymphs. Although a variety of methods have been tried, nymphs have not been kept alive for longer than ten days. Whether this is due to lack of proper environment, the right kind of food, or both, can not be said. The only possibility of tracing the life-cycle of a stone-fly, from egg to adult, seems to hinge upon a more complete knowledge of the early nymphal life.

PLATE XXIII.

- Fig. 3. Dorsal view of the nymph, natural size.
- Fig. 4. Ventral view of the nymph, natural size.
- Fig. 5. Adult female, natural size.
- Fig. 6. Mass of eggs, about 4 times natural size.
- Fig. 7. A single egg, greatly enlarged.



Lucy M. Smith.

THE LIFE-HISTORY OF A BEE-FLY (SPOGOSTYLUM ANALE SAY) PARASITE OF THE LARVA OF A TIGER BEETLE (CICINDELA SCUTELLARIS SAY VAR. LECONTEI HALD.).

By VICTOR E. SHELFORD.

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I. INTRODUCTION.

The life histories of the American Bombyliidae are imperfectly known and this lack of knowledge is due largely to the difficulty of studying parasitic forms. The species in question is never abundant and consequently much time has been consumed in getting together the data for the account here presented. Near Chicago it occurs on dry sandy places where there is much vegetation and where the sand is slightly blackened with humus. The data presented were collected mainly in connection with work upon the host which involved collecting and rearing to maturity about a thousand host larvae.

The larva of the parasite was first discovered in 1901 but it was successfully reared until 1906; the method of egg laying was not successfully observed until 1908 and 1909 while attempts to study the adult habits in 1910 and 1911 were only partially successful.

LIFE HISTORY OF THE HOST.

Cicindela scutellaris Say var. *Lecontei* Hald. is found in areas of dry sand to which considerable humus has been added by decaying vegetation (Wickham '02, Shelford '07, '11). Adults are present near Chicago from April to June and again in September. The fall individuals are those emerging from the pupal stage and are not sexually mature. These individuals during the winter in the ground, become sexually mature after the warm days in April and deposit eggs in May and early June.

Burrows of the second instar of *Cicindela* are most frequently visited. This is probably due to the fact that these holes are most abundant. The burrows of young spiders (*Geolycosa*) which have a web around the opening, are not rejected with holes of the first and third instars of *Cicindela* as well as partially covered holes produce the reaction at least once. General results of one observation are shown in table I.

TABLE I.
A SEVEN MINUTE OBSERVATION OF THE EGG LAYING REACTION OF A FEMALE
Spagostylum, JULY 16, 10:30 A. M.

Hole Producing Reflex	Stage	No. of Thrusts	Remarks
Burrow of - C. Lecontei	2 d.	7	Larva appeared.
Geolycosa	young	3-5	Web surrounding opening.
Large nondescript hole	Rejected after halt without thrust.
Burrow of - C. Lecontei	2 d.	6	Stick half covering hole.
C. Lecontei	2 d.	2	Burrow less than one cm. deep due to closing near surface probably during moult.
C. Lecontei	1st	2	
C. Lecontei	2 d.	5	Stick across hole.
C. Lecontei	3 d.	3-5	Partially covered.

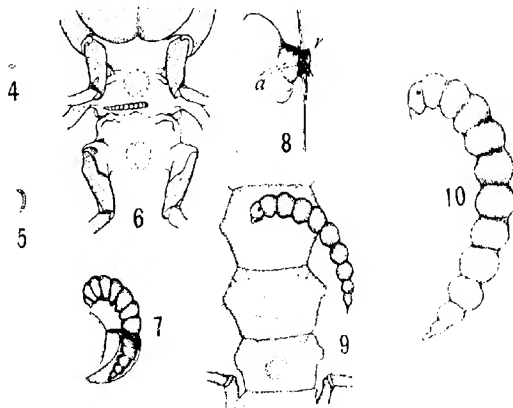
A summary of the observation of egg laying is as follows: Egg laying thrusts were executed, by two individuals observed, before holes as follows: One first larval stage of the host, eighteen second larval stages including one partially covered with a stick, and a shallow one (filled below the surface); one third stage of *Cicindela*, one small spider hole. One large nondescript hole arrested the flight but did not produce the egg laying thrust.

3. Egg, (Fig. 4).

A female taken while laying was found to contain a very large number of eggs, which could be squeezed out by a gentle pressure upon the abdomen. The eggs are light brown ellipsoids .28 mm. by .12 mm. They are not adhesive.

4. Larva (Fig. 5).

Young larvæ are most commonly found singly on the ventral side of the thorax of host larvæ of the third instar, where they cling between the legs. No second instars have been found with parasites. While in the position between the legs they cannot be reached by the host and do not come readily into contact with the sides of its burrow. There are however frequent exceptions to this, for host larvæ not infrequently have more than one larva between the legs or single larvæ on other parts of the body. One host larva had in addition to the parasite on the ventral side of the thorax, two others on the posterior third of the abdomen. Attempts to secure eggs or young larvæ from sand gathered from the edges of burrows about which eggs had been laid or to rear larva from eggs squeezed from a laying female, have failed. Neither have we



Figures 4-10. Early larval stages of *Spangolium anile* Say.

4. The egg; enlarged about five diameters.
5. A young larva of the second stage; about five times natural size, in a somewhat curved position.
6. The same in position enlarged about nine times.
7. At the time of moving to the abdomen; enlarged about five times. The larva has withdrawn its anterior half from the old integument.
8. The larva in position in the thorax, showing the ring of thickened chitin(r) in the integument of the host and the long slender mandibles in position.
9. The larva after one day on the abdomen of the host; about five times natural size.
10. The larva at the end of the second day upon the abdomen.

discovered how the larva reaches the body of the host. The host larva with the three parasites was placed in a tube of sand one inch in diameter together with two other host larvae, one bearing two parasites and the other uninfested. The double and triple infested hosts died leaving five parasitic larvae in the tube with the one live host larva. *None* of the parasites *reached the host larva*. Host larvae dug from the point where a female fly was seen to deposit eggs on July 16 had parasites of the first and second instars on the ventral thorax when removed from their burrows Sept. 23d. About 7 percent of the host larvae are parasitized. While some catches of fifty host larvae were as high as 16 percent infested others were quite free from parasites. This is particularly true in the pine area (see p. 222), where only one out of several hundred host larvae were parasitized.

The structure of the larva was but little studied on account of lack of material. The head segment bears the usual mandibles, which are long and curved. They pierce the integument of the host obliquely; a ring of thickened chitin develops about them and the mouth is brought into contact with the center of the ring and thus with the tissues and fluids of the body (Fig. 8). The number of larval moults has not been fully determined and the following account is not necessarily accurate. The smallest larvae found are from 0.5 to 0.6 mm. in length and are evidently in the first instar. These were taken in late summer and autumn and occasionally in spring. Most of these larvae moult in the fall; all pass the winter attached to the body of the host, those of the first stage moulting in early May. When the larva moults, the integument splits in the region of the thorax. The anterior end of the body is withdrawn from the old skeletal parts, leaving the old mandibular skeleton imbedded in the host. The posterior part of the larva apparently remains in the old integument until the new integument of the head region is hardened when a new attachment to the host is effected. When again attached, the larva withdraws the abdomen from the exuvium (Figs. 5, 6 and 7).

The larvae of the second instar, (length 1.2 to 1.6 mm.) probably moult again after the host has fed about a month (early June), but this is not certain because exact measurements could not be made of the small living larvae while attached to the host and they could not be removed without killing them.

A third moult takes place about the time the host stops feeding (late June), but in the cases observed, before the pupal cell is constructed. This moult clearly takes place but the larva again could not be accurately measured.

In late June the host constructs the pupal cell (*see* *Fig. 10, p. 221*) and becomes relatively inactive but does not normally pupate for a month. The parasite does not grow rapidly until the host has been in the pupal cell for about three weeks. By this time the old organs of the host have for the most part, broken down and the internal parts are in a semifluid condition. The parasitic larva now moults again and this time leaves its former position completely. In the four or five cases observed it moved to about the middle of the ventral side of the host,

(*Fig. 9*). It will be noted that at the time of the previous moults of the parasite the host was active and if the larva had completely released its hold at any of these times the result would probably have been its own destruction. At the time of this fourth moult, on the other hand, the host is almost unable to move. Immediately upon securing the new source of food through the abdomen of the host the parasite begins to grow more rapidly and more than doubles its length in 18 hours. The length at the time of the fourth moult is about 6.5 mm.; after 24 hours the length is 6.5 mm. (*Fig. 9*), and during the next 24 hours the larva reaches a length of 1 cm.

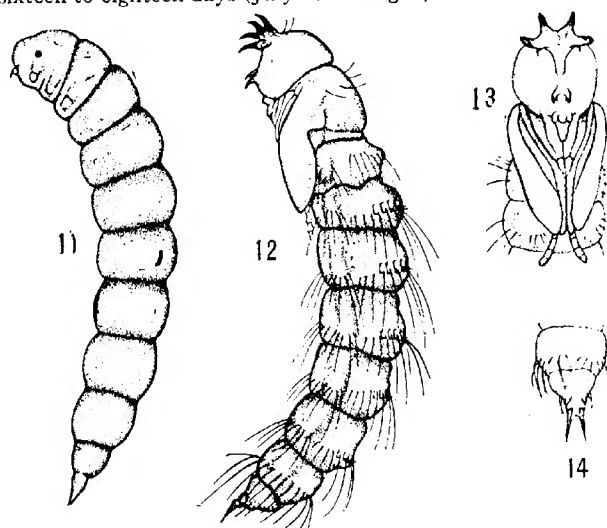
(*Fig. 10*), which is two-thirds the length of the abdomen of the host. At the end of 144 hours the parasitic larva is full grown

(*Fig. 11*). The length is now 1.8 cm. and all of the later rapid growth has apparently taken place without further moulting. The full grown larva passes six or seven days in the pupal cavity of the host in a quiescent stage before the pupal moult occurs.

5. Pupa and Adult.

The pupa is of the type common among the diptera. There are four curved hooks upon the anterior side of the head united at the base in the form of a fan (*Figs. 12 and 13*). Two smaller hooks on the ventral side of the head appear to correspond in position to the antennæ. There is a circle of long stiff bristles on each segment of the abdomen together with U shaped bristles on the dorsal side. The pupa upon emerging is unsegmented; the hooks on the head become dark in about five days; the head becomes light brown in nine days and dark

brown in thirteen days; pigment appears in the wings at the end of thirteen days in the center of the segments of the abdomen in two weeks. Pigmentation is apparently complete in about sixteen to eighteen days (July 13 to Aug. 3).

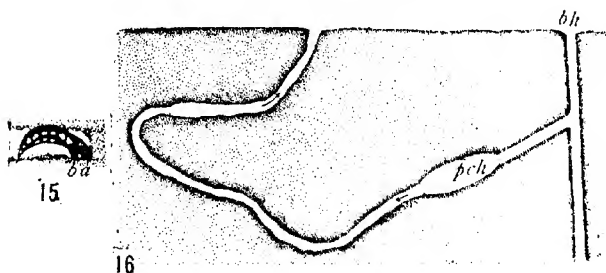


Figures 11-14. Late larva and pupal stages.

Fig. 11. Full grown larva showing the leg buds; enlarged five times.
Fig. 12. Side view of the pupa; enlarged five times.
Fig. 13. Front view of the anterior end of a fly pupa.
Fig. 14. Front view of the posterior end of the same.

Some time soon after the pigment is completely developed, the pupa begins to use the hooks for digging. In this process the numerous long stiff bristles arranged in a ring about the segments and projecting backward are of much importance for they tend to make simple movements either push the body forward or push loose sand backward. The large U-shaped bristles along the dorsal side may or may not function in this way also. The main digging operations are carried on by means of the hooks on the head. The two spines of the posterior end serve as anchoring organs. The body is curved dorsalward in the form of a bow with the dorsal side pressed against the upper side of the burrow. The U-shaped bristles prominent upon the dorsal side may function as anchors in this

operation. The two posterior spines are thrust into the floor of the burrow and the curvature is increased, which cause the head to move back as shown in Fig. 15. After a number of hoeing movements, the pupa usually wriggles backward carrying the sand with it by means of the bristles and again wriggles forward until the head is in contact with the end of the burrow. The hoeing movement is repeated or less frequently the body is rotated, the hooks serving as a boring organ.



Figures 15-16. Emergence from the ground.

Fig. 15. Diagram showing the movement of the pupa in digging its way out of the ground. Natural size (a).

Fig. 16. Showing the burrow and pupal cell of the host with the path dug by the pupa of *Spogostylum*.

The boring movement was observed in the case of one individual, the host of which had been confined in a glass tube eight inches long and one and one-half inches in diameter. The burrow and pupal cell of the host were constructed in contact with the glass. Much of the life history of one parasite was thus observed. The digging of the parasite pupa began at night, and was not noted until the middle of the next forenoon (July 15), [began in pch of Fig. 16, p. 221]. During the last eight hours the larva progressed at the rate of 1 cm. per hour. It moved in contact with the glass and traveled more than once around the tube just inside the glass. The total distance through which the parasite dug was about 24 cm. Apparently immediately upon reaching the surface the fly emerged. It left the pupal integument sticking in the burrow. The emergence of the fly was not observed as the last centimeter of digging was accomplished in less than 20 minutes and the fly emerged between observations. The adult was found resting on a small blade of grass near the hole. This adult lived only about two days.

A NEW APPLICATION OF TAXONOMIC PRINCIPLES.

By CHARLES H. T. TOWNSEND, Lima, Peru.

Scarcely more than half a century has passed since the belief was generally entertained as indisputable that species and other taxonomic categories were fixed and unchangeable entities. The basic elements of current taxonomy date a century farther back.

Our taxonomic system was founded on the principle of permanency in organic morphology, without any idea of change and evolution. In its original concept and application it was therefore inelastic and not in accord with the facts. We have been constantly endeavoring, however, to apply this inelastic system to the elastic morphology of living matter. The result is a demonstration of incompatibility between the two.

Any taxonomic system must be arbitrary and fixed in certain of its fundamental aspects, but it must also accord with phylogenetic facts. A radically new system is not here proposed, but merely a modification of the current system to fit the phylogenetic facts that we find today. It is not held that living matter is morphologically changing with such rapidity that it needs a system which will change within a lifetime in order to keep up with the progress of evolution. But it is held that living forms exhibit distinct phylogenetic phases according to the age of the stocks of which they form a part, and that this fact must be taken into account in their taxonomic treatment.

No stock is today changing rapidly enough in nature for us to note the specific steps of change. But if we pass all stocks in phylogenetic review we are struck most forcibly with the successive but gradual change of conditions exhibited as we proceed from the oldest to the youngest stocks. In such review we get an instantaneous reflection of the bimorphologic changes which take place in time.

It has fallen to the lot of the writer to make a critical study of the morphology and phylogeny of the muscoid flies, which undoubtedly comprise some of the youngest stocks of insects, and to attempt to establish a taxonomic treatment of them which shall accord with their morphology and phylogeny and

thus prove satisfactory from all practical points of view. In this task difficulties have been encountered which can only be surmounted by conforming to lines of logical simplicity. Phylogenetic facts can not be changed. The logical alternative is to change our pseudophylogenetic plan of taxonomy to a phylogenetic one.

The history of muscoid taxonomy furnishes a vivid illustration of the necessity for such change. The chronologic alternation between splitting and lumping has been constant, but always gradually tending toward greater radicalism in the former. Brauer and Bergenstamm were the first students of the superfamily to recognize the difference in phylogenetic conditions existing here and to put the idea into words. Their system of taxonomy shows that they approached much nearer to the truths of phylogeny than had any former students of the group, but they failed in many cases to grasp the relationships because they had no uniformly true criterion thereto in the external adult anatomy. It has been left for students since their time to discover criteria in the reproductive system and early stages that furnish unmistakable clues to these relationships.

It was the good fortune of the writer to figure largely in the last named investigations, and therefore to obtain facts which constitute a definite basis for phylogenetic deductions. Once such deductions are authoritative—recognized as unmistakably founded on fact—we are able to proceed with confidence in the separation of forms of diverse origin, however similar may be their external morphology. This process brings us face to face with phylogenetic facts that could never before be confidently accepted, and with many which were never before suspected to exist. It compels us to draw lines where such were never before imagined, and it emphasizes with extreme force the shortcomings of current taxonomy if applied to young stocks.

The writer claims in this connection nothing more than a clear view and conscientious record of what has come within his range of vision. The privilege of applying a phylogenetic key to the taxonomy of some of the youngest and most obscurely differentiated groups of insects has been his, and it has furnished him an insight into the relationships of these groups and into the taxonomic needs of young stocks in general that was only

dimly comprehended before. The one who uses this key conscientiously and with fair judgment must get this insight. It only remains to bring the taxonomy into accord with the conditions. This is no simple matter, but it is capable of adjustment.

A careful comparative study of muscoid conditions by the writer, extending over the past five or six years and beginning before the reproductive and early-stage criteria became available has resulted in what may be called the typic-atypic application of taxonomic principles. The idea was dimly comprehended in 1907 from a study of the external adult anatomy alone and published in May, 1908 (*Tax. Musc. Flies*), while a clearer perception of it was gained and the foundation for its practical application laid during the next few months and the results published in September, 1908 (*Rec. Res. from Rear. and Dis. Tach.*). From that time to the present the typic-atypic idea in taxonomy has kept pace with the progress of the investigations into the reproductive and early-stage characters of the muscoid flies as compared with their external adult morphology. The working out of the scheme of application with the view of ultimately bringing it to a point of completeness has been laborious in the extreme, and many mistakes and new starts have been made. Theoretical phylogeny and a taxonomic application to match have been constantly checked up by practical and actual phylogeny, thus showing errors that have had to be corrected.

The writer has been still further fortunate in being able to spend some time during the past three years, 1910 to 1912, in several districts of the Andean montanya in Peru and Ecuador, perhaps the most favored biotic region on earth and thus the best adapted to illustrate the working out of phylogenetic principles in nature. Here he has been tremendously impressed with the extreme richness in transitional forms displayed by certain of the youngest muscoid stocks, which have furnished additional proofs of the soundness of the typic-atypic system of treatment. A paper on these forms is forthcoming (*New Gen. and Spp. Musc. Flies, chiefly Hystriciidae from the And. Montanya*).

The typic-atypic system calls into use the new group-unit category, which includes the typic genus and such atypic genera as approach more closely to it than to any other typic

genus. It has gradually become evident that this category is a natural prime division of the subtribe, demanded in young stocks where transitional forms are numerous present but not as a rule called for in older stocks where such transitionals are infrequent.

It may be pointed out by way of illustration that we know many insect stocks whose component forms are well differentiated from each other; we know other insect stocks whose forms are less markedly differentiated among themselves, and we know still further stocks which comprise masses of closely similar forms. The first are old stocks, the second are middle-aged stocks practically in their prime; the last are young stocks, still undergoing evolution and characterized by the presence of many transitional forms. The same system of taxonomy is not applicable to all these classes of stocks. The three classes mentioned are of course not clearly delimited, for certain stocks are bound to be intermediate between them. But each stock can always be treated on its own merits. For the first class in general, the current system of taxonomy answers fairly well—that is to say, the tribes are usually quite easily divided directly into genera. In the second class, comprising in general the stocks of middle age, we need the subtribal category between the tribe and the genus. In the youngest stocks we need to employ still another category, as an elementary grouping of genera, between the subtribe and the genus. This is what has been termed the group-unit, for it is both theoretically and practically the unit of taxonomic groups.

So far as it has been possible to work out the status of the group-unit to date, its value appears to correspond to a fractional part of the contracted subtribal value and the whole or a part of the transitional subtribal value, as these values are exhibited in young superfamilies and stocks undergoing evolution. The group-unit therefore corresponds to the well marked genus in the old stocks, plus its intergeneric space which is conceived to be a fixed quantity covering certain transitionals that have dropped out. The well marked genus itself corresponds to the typic genus of the group-unit, while the latter has associated with it various transitional or atypic genera which are not represented in the old stocks but must here be fitted into the taxonomic system. These transitionals or atypic genera are the subgenera of the typic genus. They are subordinated to

The elemental combinations of genera must thus constitute the units of group formations and values. It is proposed that the name of the group-unit be formed by adding *iæ* to the root of the name of its typic genus. This does not conflict with any of the group endings established by the International Code and by general usage.

The group-unit permits us to arrange with phylogenetic fidelity the components of stocks whose transitionals are largely present, fitting all into a natural taxonomic system. There can be not the slightest doubt that this category is an absolute necessity to the clear and concise taxonomic handling of the forms that comprise the youngest stocks. The further details of the new application of taxonomic principles here outlined largely remain to be worked out. This must be done by applying the principles to the young stocks themselves as they exist today.

A STUDY IN ANTENNAL VARIATION.*

By EDITH M. PARCH.

PLATES XXIV-XXVII.

During the summer and fall of 1912 annulation counts of 1243 antennae of *Schizoneura* developing on *Ulmus* (leaf and bark), and *Pyrus* and *Crataegus* (bark) were made by Mr. William C. Woods and the writer of this paper.

A detailed record of the annular sensoria present on each of joints III, IV, and V of every antenna counted, giving a tabulation of 3729 counts in all, is preserved on file at the Maine Agricultural Experiment Station and a copy of this record will be lent upon request to any one making a particular study of the species concerned. The counts in tabular form are too bulky to be conveniently printed as they stand; and as nearly 100 curves would be necessary to cover the various collections adequately that method of presentation was also rejected for the time though part of the data may be reduced to this form later.

The drawings of the 90 antennae selected show, however, the most significant ranges of variation and give in themselves a summary sufficient for most purposes. The antennae are all drawn to the same scale with particular reference to the number of annulations present on each of the joints III to V and where of interest also of joint VI; and the length of each joint. No especial attention has been paid to other antennal details and the drawings are not to be considered a study of the terminal joint except in the two respects indicated. In some instances the drawings were made from mounts in which the antenna was curved on the slide and an arbitrary correction of this for the purpose of getting approximately straight drawings for plates, gives the peculiar irregularity in contour apparent.

Frequent examples of freak antenna in which two joints were apparently merged were met and some of these are represented by Figs. 32-36 and Fig. 82.

Appreciative thanks are due to several widely scattered entomologists for their kindness in sending material from different localities, who are, in part, acknowledged in the collection data which follow.

*Papers from the Maine Agricultural Experiment Station; Entomology No. 62.

History of Collections Tabulated.

39-04. (Fig. 74). Elm rosette. Orono, Me. June 15, 1904.

6-05. (Fig. 90). Mixed collection from elm leaf roll and rosette. Orono. June 16, 1905.

95-06. (Figs. 19-21). Elm bark. Orono, Aug. 4, 1906.

114-06. (Fig. 29). Crataegus bark. Maine. Sept. 17, 1906.

115-06. (Figs. 30-31). Apple bark. Maine. Sept. 17, 1906.

7-08. (Fig. 22). Elm bark. Orono. June 16, 1908.

50-09. (Figs. 14-18). Elm leaf collection. Brewer, Me. July 1, 1909.

63-11. (Figs. 23-26). *Pyrus* sp. bark. (cultivated variety of mountain ash). Orono. Aug. 28, 1911.

64-11. *Pyrus sitchensis* (Roem.) Piper, bark. Orono. Aug. 29, 1911.

6-12. (Fig. 13). Elm leaf roll. Alabama. Received May 6, 1912. Progeny of this collection lived for a fortnight on apple seedlings.

9-12. (Fig. 11). Elm leaf roll. Columbia, Mo. Received May 12, 1912, from Dr. L. Haseman. The winged progenitors of 9-12. Sub. 1. (Fig. 27) which were reared in the laboratory on apple seedlings. A fuller account of this collection is given in Bulletin 203 of the Maine Agricultural Experiment Station.

9-12. Sub. 1. (Fig. 27). Apple seedling. Laboratory bred. Sept. 20, 1913. The progeny of 9-12 which see for discussion.

11-12. (Fig. 12). Elm leaf roll. Knoxville, Tenn. Received May 20, from Dr. Gordon Bentley. Progeny of this collection were reared on apple seedlings from May 20 to June 26.

12-12. (Fig. 10). Elm leaf roll. Marion, S. C. Received May 28, 1912, from Mr. W. A. Thomas.

21-12. (Fig. 89). Mixed collection from elm leaf roll and rosette. St. Louis, Mo. Received June 3, 1912, from Mr. J. T. Monell.

29-12. Elm rosette. Orono. June 6, 1912.

30-12. (Figs. 83-88). Elm leaf roll. Marion, S. C. Received June 8, 1912, from Mr. W. A. Thomas.

35-12. (Figs 8 and 9). Elm leaf roll. St. Louis, Mo.
Received from Mr. J. T. Monell, June 14, 1912

43-12. (Fig. 2). Elm leaf roll. Orono. June 20. For
discussion see 113-12.

45-12. (Fig 68). Elm rosette. Calais, Me. June 21, 1912.

49-12. (Figs. 76-82). Elm rosette. Standish, Me. June
24, 1912. The rosette was old and considerably dried and the
migrants were smaller than those from fresher and juicier
rosettes.

53-12. (Figs. 3 and 4). Elm leaf roll. Orono. June
26, 1912.

57-12. (Fig. 69). Elm rosette. Caribou, Me. June 26,
1912.

58-12. (Fig. 75). Elm rosette. Berlin, N. H. June 28,
1912.

60-12. (Figs. 32-67). Migrants developed in elm leaf
roll and rosette. Collected June 28-July 12, 1912, from the
ventral surface of leaves of *Pyrus americana* (Mountain Ash),
to which they had migrated. A fuller account of this collection
is given in Journal of Economic Entomology, Vol. 5, p. 397.

61-12. (Figs. 70-73). Elm rosette. Oakland, Me. June
29, 1912.

65-12. Elm rosette. Orono. June 21, 1912.

68-12. (Fig. 1). Elm leaf roll. Houlton, Me. June,
1912.

111-12. (Fig. 5). Elm leaf roll. Orono. July 20, 1912.

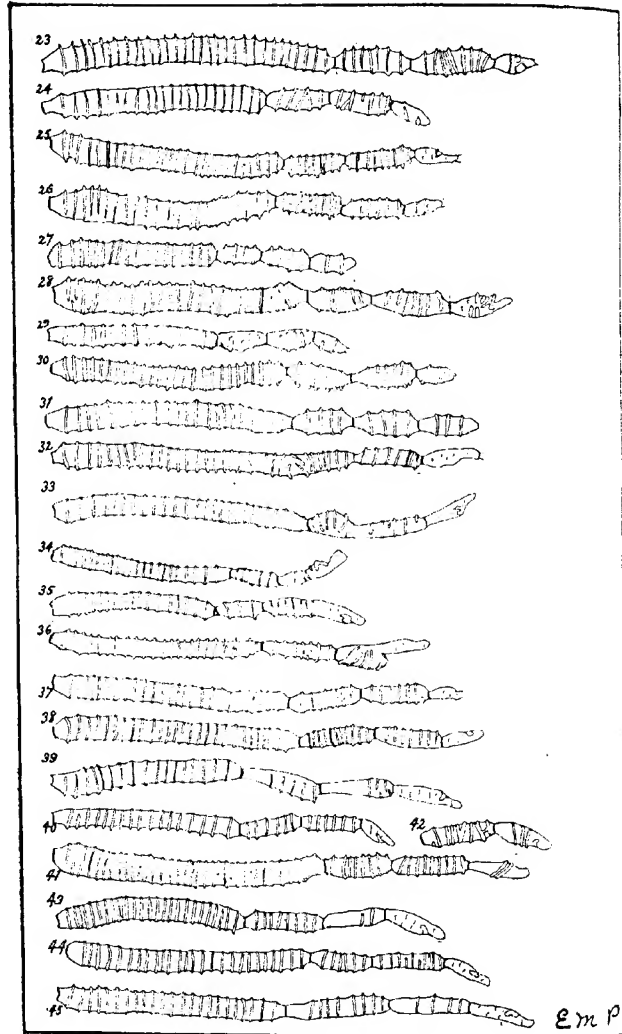
113-12. (Figs. 6 and 7). Elm leaf roll. Orono. July 23,
1912. Purposely collected late for comparison with 43-12
(Fig. 2) which developed June 30 in the same rolls. The
difference in the actual size of the antennae and in the number
of annulations of the big, thrifty early ones from the juicy leaf
and the last individuals to develop in the drying roll would
seem suggestive of the physiological effect of the habitat on the
size of the individual and the character of the antennae.

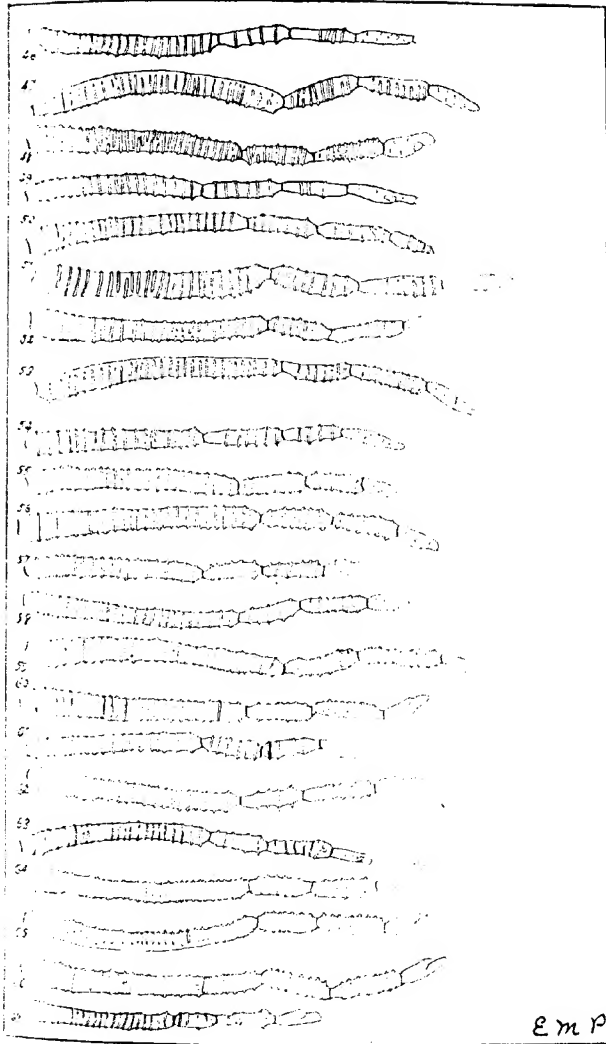
165-12. *Pyrus sitchensis* Piper, bark. Orono. Sept. 24,
1912.

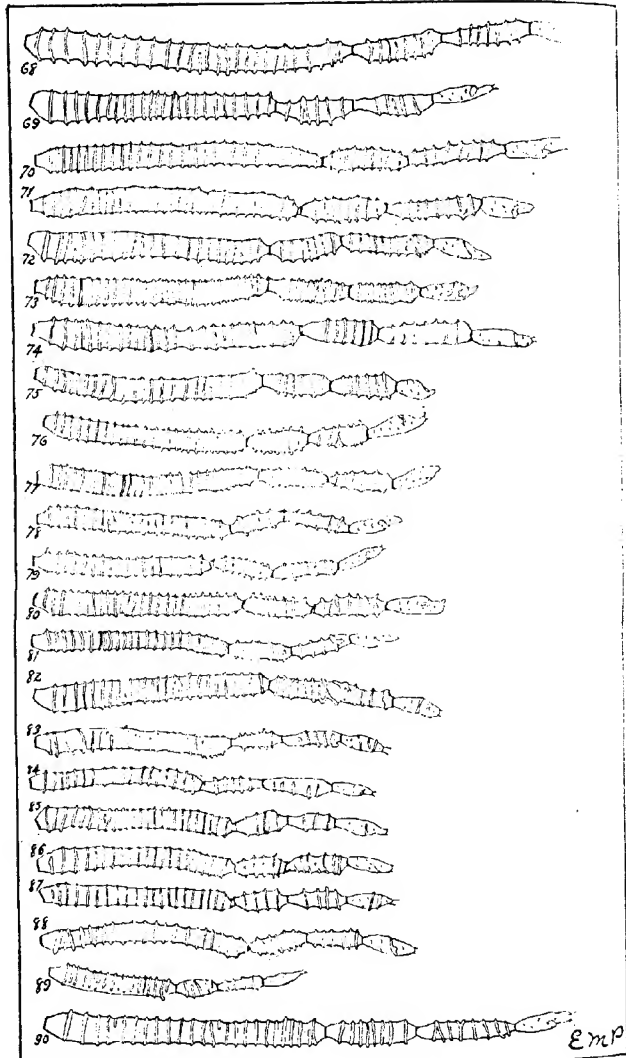
175-12. Apple bark. Orono, Me. Sept. 28, 1912.

176-12. (Fig. 28). *Crataegus (monogyna) Oxyocantha*. St.
Louis, Mo., September 27, 1911. Mr. J. T. Monell.

NOTE. By elm leaf "roll" is indicated a deformation of a single leaf. By
"rosette" is indicated a terminal cluster. (Figs. 442 and 462, Bulletin 203, Me.
Expt. Sta.).







**A STUDY IN VARIATION IN THE NORTH AMERICAN
GREENBOTTLE FLIES OF THE GENUS LUCILIA,
WITH SYSTEMATIC NOTES ON THE
SPECIES INVOLVED.**

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Some few years ago the writer had occasion to make a study in variation of the Canadian species of the genus *Lucilia*. Series of adults were bred, more particularly in the case of *L. sericata* Meig., and from the material thus secured the limits and possibilities of variation in certain directions were determined. The fact was brought out that none of the characters made use of by Mr. C. H. T. Townsend in his "Taxonomy of Muscoidean Flies" for the erection of the ten supposedly new species of the genus contained in that publication are of specific value.

In 1911 an opportunity was afforded of examining the types and cotypes of the above ten species at the U. S. National Museum, in Washington, D. C. The conclusion which had been previously arrived at namely, that the supposed species were only variations of the original four species as recognized by Hough was abundantly justified.

Examinations of the ♂ genitalia were made and these again showed that the conclusion was justified.

It is hoped shortly to publish the results of the study of the ♂ genitalia.

The present paper consists of the results of the study in variation, and of the examination of the U. S. N. M. *Lucilia* material.

A STUDY IN VARIATION IN THE GENUS LUCILIA.

That variation in external morphological characters is a factor to be reckoned with in systematic entomology is today disputed by no working entomologist. At the same time there are comparatively an infinitely small number of the vast array of insects described to date which have had their limits of variation approximated.

That such approximation is possible or practical in all cases cannot be entertained; that it is desirable is beyond question. The single historic example of the tachinid fly *Exorista (Phryxe)*

vulgaris Fall. with its five and one-half pages of synonymy in the "Katalog der Paläarktischen Diptera" is sufficient in itself to establish the desirability of studies in variation.

The present study is concerned with three species of the genus *Lucilia* i. e. *sericata* Meig., *sylvorum* Hough and *caesar* Linn. The method adopted was to breed from isolated egg masses series of adults, examine and record certain selected characters for each fly from each egg mass, tabulate these characters, make synopses of these tables, and finally to draw up from these synopses résumés or extended definitions for each species.

Owing to lack of space only these final résumés appear in this paper. It was the intention of the writer at the outset to keep exact records of at least one hundred examples of each species encountered. This intention was however only realized in the case of *L. sericata* in which case several hundred adults were reared. The number of specimens of each species reared and examined is as follows:

- L. sericata*, Meig., 158 consisting of 57 ♀♀ and 101 ♂♂.
- L. sylvorum*, Hough, 27, consisting of 25 ♀♀ and 2 ♂♂.
- L. caesar*, Linn., 3, consisting of 1 ♀ and 2 ♂♂.

In addition to these bred specimens ten collected specimens of *L. sylvorum* and thirty-one *L. caesar* were also examined, the results being included in the following résumés. This makes the total assemblage of flies for each species: *L. sericata*, 158; *L. sylvorum*, 37; *L. caesar*, 34.

The characters selected for examination were as follows:

- Dorsocentral bristles.
- Posttracostichal bristles.
- Humeral bristles.
- Sternopleural bristles.
- Ocellar bristles.
- Width of front.
- Colour of palpi.
- Colour of first abdominal segment.
- Marginal bristles of second abdominal segment.
- Colour of tegulae.
- Width of apex of first posterior cell compared with the length of the anterior cross-vein.
- Presence or absence of appendage at bend of vein four.

These particular characters were chosen for two reasons (a) to find if possible new taxonomic characters for the separation of the species; (b) on account of the fact that they include all the new characters employed by Mr. C. H. T. Townsend* in the erection of ten supposedly distinct species.

* Taxonomy of Muscoidean Flies. Smithsonian Misc. Col., Vol. 41, No. 1493.

RESUME OF *L. SERICATA*.

In all cases there were three strong pairs of dorsocentral bristles, no rudimentary fourth pair.

In 98.1% of cases there were three pairs of postacrostichal bristles. One of the variations was an extra spasmodically placed bristle of the mesonotum (postsutural). The other variation was that of two postacrostichals only on the left side; this may indicate a past connection between the forms with typically three pairs and those with typically two pairs (*L. caesar*).

As regards humeral bristles 88.7% of the flies examined were supplied with four strong ones on each side. The variations ranged between a form with two on one side and three on the other and the typic form with four on each side. The anterior bristle was always the one to be lost.

The interior bristle seems to have a taxonomic affinity toward the anterior bristle, as in the case of the latter aborting it was usually found that the interior bristle was weak (in one case it was lost completely on one side).

There were in 96.9% of cases 3 sternopleural bristles on each side. This is a generic character and yet there was variation, not in the species as a whole, but in individuals. These variations were in an increase and decrease of these bristles in both number and strength. In all cases the posterior bristles were constant and the anterior alone became modified.

The ocellar bristles varied according to sex.

82.5% of the female flies had two well-defined pairs. In the great majority of these cases the anterior pair was longer and stronger than the posterior pair, but at the same time the latter pair was sufficiently strong to warrant the application of the term 'bristles'. As to position the anterior pair had their insertion within the ocellar triangle and the posterior pair had theirs outside of the triangle and immediately posterior to it. As to the exceptions to this normal condition of two pairs there were a few cases in which the post. pair were weak; one case in which the two pairs were both exceptionally strong; several instances in which there was an extra *bristle* developed on one side within the ocellar triangle and posterior to the normal anterior pair; and finally a few instances in which there was an extra *pair* of bristles developed within the ocellar triangle and post. to the ant. pair.

Of the males 90% had only one pair of ocellar bristles. These were proclinate and had their insertion within the triangle. There was a tendency toward the production of two pairs; in some cases this second pair was hardly stronger than the surrounding hairs; in 7% of cases they had developed into a weak posterior pair; and finally in a solitary instance two distinct pairs were developed.

The width of front affords a secondary sexual character. This character was very constant, there being practically no variation in all the material examined.

In the females the width was one-seventh to one-eighth head width. Hough in his description of this species gives one-sixth to one-eighth head width; this will hold good if that portion near the ocellar triangle is taken into consideration, as at this extremity there is an expansion. In the present study, however, the term width of front is restricted to that portion of the front immediately above the base of the antennae, i. e. the narrowest portion.

In the case of females the width of front was from one-tenth to four-tenths head width.

It may be stated here that measurements of all these flies was not attempted. A small series however of each sex were measured in this particular and with these as a guide the other specimens were visually compared. This may sound somewhat casual, but in reality the method is reasonably accurate as the observer very quickly acquires a due sense of proportion.

The next character lies in the color of the palpi. This character was sometimes very difficult to determine because the palpi were often retracted into the oral cavity. The wall of this cavity varied from an amber yellow color to almost black and the palpi, being semi-transparent, appeared in many cases to be of this dark color and only by removing them could the fallacy be made patent. Again these palpi were covered with fine white hairs and thus in certain planes of vision they appeared white.

The prevailing color of these palpi was amber yellow. This was however by no means constant, there being but 64.4% of the flies with the palpi of this color. The color varied from pale yellow through dark amber yellow to almost black; again in several cases there was an infuscation or dark area at the distal region; and also a black area was occasionally present

at the base. Thus for this species at least the color of the palpi is not constant and the infuscation at the tip has no specific value.

In the color of the first segment of the abdomen was found an excellent secondary sexual character. In all cases it is the dorsal area of the segment that is referred to and not the ventral.

In all males examined the first segment was, at least superiorly, black. In the females this segment varied from the color of the remaining segments (i. e. abdomen unicolorous) to a shade darker; there were few examples of this latter condition.

On the second abdominal segment there was superiorly a row in both males and females, of fairly strong marginal macrochaetae. These macrochaetae were stronger centrally, then became weak and finally became strong again at the sides. These bristles varied slightly, but not to any marked degree; in a few cases they were strong and in a few cases weak; in two instances (1 ♂ and 1 ♀) the two median bristles stood out more prominently thus approaching the condition in *L. sylvorum*.

The tegulae varied from white to brown. This variation was evident in all the series of flies of all species and in one lot of *L. sylvorum* bred from a single egg cluster all intermediate stages were found between the pure white and the brown conditions.

Before passing to the next character it may be well to observe that all flies killed and pinned soon after the time of hatching have pure, or almost pure, white tegulae; and that only in flies that have either been collected, or bred through and left in a cage for ten days or more, have the brown-tinged tegulae been observed. This seems to indicate that the tegulae darken as the fly grows older.

It was found that the width of the apex of the posterior cell in comparison with the length of the anterior cross-vein was slightly or distinctly shorter; the only exception to this was in the case of two flies in which the lengths were equal. This character has not previously been made use of. It is apparently very constant and serves as a separating character for this species from *L. sylvorum*.

The character is best seen when the wing is viewed from below. In vein 4 there was in no case any appendage—even rudimentary—at the angle.

RESUME OF *L. SYLVARUM*.

There were in all cases 3 strong pairs of dorsocentral bristles, but in 33% of the flies resulting from one egg cluster there was a trace of a fourth anterior pair; sometimes this trace exhibited itself as a slightly exaggerated hair on one side only and sometimes it resolved itself into a distinct but weak pair of anterior dorsocentral bristles. There were three pairs of strong postacrostichal bristles in all cases.

As regards humeral bristles there were in most cases four on each side. The majority of variations ran to an abortion of either one bristle on one side only, or of a bristle on both sides. This bristle was always the anterior bristle and, as in *L. sericata*, the loss of it carried with it a weakening of the anterior one. There was in one case a variation in the other direction, namely, the development of an extra bristle, quite strong, on one side only.

Sternopleural bristles were represented by three typical pairs, but, as in *L. sericata*, there was variation, notwithstanding the fact that the character has an undoubted generic value. This variation appeared in 4 specimens and ran in each case to an additional anterior pair, represented either by a bristle on one side only or by a bristle on each side; these bristles were sometimes weak and sometimes strong. In all cases as in *L. sericata*, only the anterior bristles were subject to modification.

Coming to ocellar bristles it was found that, as in *L. sericata*, these afforded secondary sexual characters. The four males had only one strong pair of ocellar bristles. These were preclinate and inserted within the ocellar triangle.

The females had one strong pair inserted within the ocellar triangle and one very weak pair inserted outside the triangle and immediately posterior to it. This weak pair was made up of somewhat exaggerated hairs but the term bristle is perhaps applicable because they stood out from the surrounding hairs (of which there were several pairs). There were in the specimens of this species as in the specimens of *L. caesar* a few hairs within the ocellar triangle. There was variation from the typical condition of one strong pair and one weak in two directions, namely, reduction of the posterior pair and the addition of another posterior pair of these weak bristles or strong hairs.

The width of front affords a secondary sexual character. In the males the front was from one-tenth to one-twelfth head width. Hough gives the width as "very narrow" and "one-eighth to one-tenth head width." A better way is perhaps to say that the width of front in ♂ *L. sylvarum* comes intermediate between that of *L. caesar*, which is linear, and that of *L. sericata* which is from one-seventh to one-eighth head width. Once having examined specimens as to this character in males of all three species it becomes a comparatively easy task to subsequently reduce any male *Lucilia*, on this character alone to its species.

The front of the females was found to be somewhat narrower than in *L. sericata* and about the same as in *L. caesar*. In actual width it was found to be about 3-10 (measurements were made in a number of specimens) of the head width; this is slightly less than 1-3 head width. This character serves very nicely for separating females of this species and of *L. caesar* from females of *L. sericata* which have a front measuring 4-10 head width, or slightly greater than 1-3 head width.

The color of the palpi appears to be far more constant in this species than in *L. sericata*. This color was dark brown or almost black in all but two cases and in these it was black. The color of the dorsum of the first abdominal segment was *not* in this case found to afford a secondary sexual character as in *L. sericata*. In the females the first abdominal segment was either blackish or black, and in the males it was black.

A comparative study of the bristles of the second abdominal segment produced some curious results. In the case of *L. sylvarum* one bred male had a strong pair of median marginal bristles and no differentiated marginal row. 68% of the females in the same lot had a strong central pair of bristles and a weak marginal row; several flies had the central pair no stronger than the remaining bristles of the marginal row. Again in another lot of bred material of 7 females two exhibited this latter condition of having the central pair no stronger than the others.

This variation is important because the presence of a pair of strong median marginal macrochaetae has always been attributed by writers to *L. sylvarum* and here it is shown that the character may vary to quite a considerable extent.

In most cases the central pair were of about the same strength as the remaining bristles. As a rule, however, these

two bristles stood out at right angles, or at least at a considerable angle, to the longitudinal plane of the abdomen; whereas the remaining bristles were barely elevated and extended over the dorsum of the third segment. Thus these central bristles stood out as two distinct macrochaetae. It not infrequently happened however that these central bristles were not elevated and hence they could not be readily distinguished from the others of the marginal row and inference was naturally drawn that they were not present. Their presence could usually be detected by examining the sites of their insertions as compared with those of the remaining bristles; the central pair had their insertions very slightly anterior to the row of marginal macrochaetae.

The tegulae varied, as in *L. sericata*, from white to smoky; in one lot of bred material particularly an excellent gradational series, in respect to this character, was obtained.

The apex of the first posterior cell of the wings was, unlike the condition in *L. sericata* or *L. caesar*, longer than the anterior cross vein. This character is best seen from the under surface of the wing. It is apparently one of the best for separating this species from *L. sericata*. There was often a short spur at the angle of the fourth longitudinal vein.

RESUME OF *L. CAESAR*.

In all cases there were three strong pairs of dorsocentral bristles and there was no rudimentary or vestigial fourth pair.

In all cases but one, two pairs of postacrostichal bristles were found to be present. In this one exception there was an extra pair erratically placed.

The humeral bristles varied considerably. In the bred specimens there were two flies with two pairs and one fly with three pairs. The most common condition was two pairs, but there were a number of specimens with an extra anterior bristle on each side, and again others with a complete anterior fourth pair. At the other extreme there was a fly with two bristles on one side and three on the other. There was thus greater inconstancy of humeral bristles in this species than in either of the other two. It is interesting to note that it was always, as in *L. sericata* and *L. sylvarum*, the anterior bristles and of these the interior pair that were subject to variation.

The sternopleural bristles were represented in all cases but one by the normal three pairs. In this one exception the anterior bristle on one side was reduced to a long hair. It was the anterior bristle that became modified.

The ocellar bristles, as in the other two species, afforded secondary sexual characters.

The males had in all cases the one strong proclinate pair as in *L. sericata* and *L. sylvarum*, having insertion within the ocellar triangle. The females had the usual one strong pair having insertion within the ocellar triangle. The posterior pair were in most cases reduced to hairs, thus being less strong even than in *L. sylvarum*. There was one curious variation in which there were one strong pair and two very weak pairs of bristles; both these weak pairs were posterior to the strong anterior pair; one of them was inserted within and the other outside of the ocellar triangle. There were in addition to the bristles a number of hairs both within and outside of the triangle.

The color of the palpi was, in the specimens of this species examined, very constant. It was without exception amber yellow.

The width of front here again afforded a secondary sexual character. All the males had the front linear; it was considerably narrower than in *L. sylvarum*, and very considerably narrower than in *L. sericata*. In the females the width of front varied from three tenths to one third head width; the more general condition however was about three tenths, or the same as in *L. sylvarum*.

The color of the dorsum of the first abdominal segment varied from that of the remaining segments (abdomen unicolorous) to black. Between these two extremes there were numerous gradational variations; the most common of these was that in which the segment was somewhat darker, especially centrally, than the remaining segments.

As to the color of the tegulae there were found to exist the same variations as in *L. sylvarum* and *L. caesar*. The extremes were white and brown and between these were found numerous combinations. The more common condition was that of 'tinged brown.'

Regarding the last character, namely, the comparison in lengths of the apex of the first posterior cell and anterior cross

vein it was found that this species comes in this respect midway between *sericata* and *sylvarum*. In four cases the apical margin of the first posterior cell was slightly shorter than the length of the anterior cross vein, which is the typical condition in the case of *L. sericata*. In the remaining twenty seven flies it was about equal to the length of the anterior cross vein. Thus for this species the character will not serve to differentiate from the other two species.

Having completed the résumés for the three species of *Lucilia* the opportunity may be taken to make a few general remarks on characters which have not been made use of in the tables.

First, as to size, there was found to be little difference in the three species. Possibly *caesar* is generally somewhat larger than the other two. In each species there is however a considerable variation. To illustrate this it may be said that in over 200 specimens of *sericata* the smallest fly was 5 mm. long and the largest 9 mm.; the average length was from 7 to 8 mm.

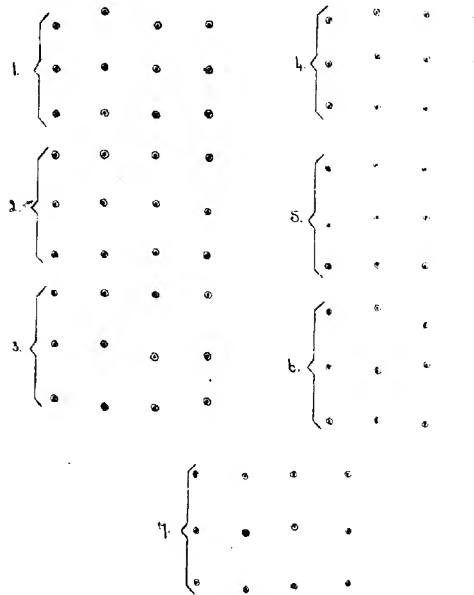
Then as to general color there was again a great range of variation. Hough makes remark* that 'In all the Calliphorinae of metallic color the shade varies through violet, green, blue and copper color.' One has only to look at a long series of *Lucilia* to find that, in this genus at least, the remark holds true. Generally, however, flies of *L. sericata* are brighter, owing to a greater preponderance of the coppery color, than are those of *L. caesar* and *L. sylvarum*.

Lastly a word may be said regarding the positions of the dorsocentral and postacrostichal bristles both in relation to the respective series separately and in relation to one another. As to the positions in their respective series it was found that they were placed, almost without exception, in the same plane longitudinally (cephalad-caudad) although there was variation. Then as to the relative positions of the dorsocentrals and postacrostichals there was found to exist a considerable variation: taking any four bristles transversely an imaginary line drawn through their insertions usually approached a straight line; this line was however scarcely ever absolutely straight and the deviations from it did not follow any definite plan. The

*Synopsis of the Calliphorinae of the U. S., Zool. Bull., Vol. II, No. 6, Sept. 1899, p. 283.

accompanying diagram showing the positions of these thoracic bristles in the case of seven flies all bred from a single parent indicate this variation better than can any description.

The point is of interest on account of the fact that Mr. Townsend (loc. cit. p. 121) in describing a new species of *Lucilia* (*L. giraulti*) makes use of the relative positions of the postacrostichal and dorsocentral bristles.



DIAGRAM

Showing variation in relative position of dorsocentral and postacrostichal bristles in the case of 7 specimens of *L. sericata*, all bred from the same parent fly.

Legend:

Each dot within a circle represents the insertion of a bristle.

Each bracketed group (of the total 7) represents the dorsocentral and postacrostichal bristles of one fly.

The two outside rows of bristles are dorsocentrals.

The two inside rows of bristles are postacrostichals.

The chief value of this study in variation lies in the fact that each species dealt with was found to be subject to considerable variation in the matter of chaetotaxy, color, size, etc. Also in that all the new characters used by Mr. Townsend (loc.

cit.) for the erection of the ten supposedly distinct species are shown to come within the limits of variation of the North American species of *Lucilia* as recognized by Hough.

NOTES ON THE TYPES AND CO-TYPES OF LUCILIA SPECIES IN THE
U. S. NATIONAL MUSEUM.

The following notes were made in 1911, through the courtesy of the U. S. National Museum authorities, on the types and cotypes of Mr. Townsend's supposedly new species of *Lucilia*. In some cases the Taxonomy of Muscoidean Flies, Smith's Misc. Col., Vol. 41, No. 1803, notes refer to the original descriptions. The value of certain characters employed in these descriptions is discussed in the preceding portion of this paper.

Lucilia morilli. Town.

The type specimen together with all the co-types are *Pandopyrellia cornicina* Fab. There are no hypopleural bristles and the fourth vein is curved and not angular.

Lucilia nigripalpis. Town.

The type specimen must be referred to *L. sylvorum* Meig. The width of front is slightly less than one-third head width; the palpi are blackish; the first segment of the abdomen is blackish; on the second segment of the abdomen there is a well marked pair of median marginal macrochaetae quite as strong as are found in most specimens of *L. sylvorum*. The abdomen is however 'dented' in consequence of which the macrochaetae are appressed against it and this is presumably the reason that they were overlooked by the author of the species; there is a weak pair of extra ocellar bristles just posterior to the ocellar triangle and quite typical of *sylvorum*; in the comparative lengths of the apex of the first posterior cell and the anterior cross vein the fly is typically *sylvorum*.

The co-type is an undeveloped specimen of *L. sylvorum* Meig; the head characters are all typical except in the color of the palpi which are distinctly brownish, especially toward the base; the lower side however of the abdomen and also the legs both show this light color which means that the fly was captured soon after issuing; toward the tip the palpi become blackish and this is carried down one fourth distance to base; as to marginal macrochaetae on the abdomen there is a weak pair on the second segment which show up better when the fly is examined from the dorsal side; when the specimen is viewed laterally there is seen to be one other bristle near the center of the same segment; it is about as long as the shorter of the central pair but the base is weaker.

Lucilia angustifrons. Town.

The type specimen is a ♂ from England and the single co-type is a ♀ from Kaslo, B. C., which "seems to be this form" (Townsend, Taxonomy of Muscoidean Flies, p. 120). An examination of the type shows that a third and anterior pair of postacrostichal bristles is present; at the same time both these bristles are weaker than those situated posterior to them in the same rows and moreover the bristle on one side is decidedly less strong than that on the other side (the one on left side is weaker). This is the only character that separates the fly from typical *L. caesar* and as in this very character there is an irregularity it seems highly probable that the pair of bristles is nothing but a sport in which case the form must be referred to *L. caesar* Linn.

As to the single co-type, the ♀ from Kaslo, this fly has two postacrostichal bristles on one side and three on the other with the anterior one weak; the fly is unquestionably *L. caesar* Linn.

Lucilia giraulti. Town.

One ♂ from Paris, Texas, no cotypes. In the original description of this species (Townsend, Taxonomy of Muscoidean Flies, p. 121) there is only one character mentioned that would separate the form from *L. sericata* Meig. which is that "a second pair of ocellar bristles is present." Even were this so the character would be insufficient in itself as the study of variation for *L. sericata*, brought out the fact that in this species there is occasionally developed a second pair of ocellar bristles. An examination of the specimen itself however shows that the bristles in question are *not* developed. The fly is therefore *L. sericata* Meig.

Another character used in the description of this species is the position of the postacrostichal bristles relative to the dorsocentrals. The study in variation brought out the fact that this character has no determinative value. The above specimen is badly mutilated.

Lucilia barberi. Town.

A discussion of this supposed species is hardly necessary. All the characters employed to separate the form are met with

in *L. sericata* Meig. An examination of the type specimen and also of four cotypes shows that the form may be referred to *L. sericata* Meig.

Lucilia unicolor.

Five ♀ specimens from New Mexico, Mexico and British Columbia. They are all *L. caesar* Linn. The second pair of ocellar bristles is fairly strong in the type specimen, but in the co-types there is variation and they become less strong, in any case all come within the limits of variation of *L. caesar*.

Lucilia purpurea. Town.

There is no character in the description of this form which serves to separate it from *L. caesar* Linn. In the description it is stated that "the whole body is purplish, strongly violet tinged, especially in the ♀." This is certainly somewhat of an unusual hue for *caesar*, but a series can be arranged from the U. S. N. Museum material showing all gradations from this form to almost pure green. An examination of the type and co-type shows that there are no structural characters separating the form from *L. caesar* and the name *purpurea* Town. must therefore sink.

Lucilia australis. Town.

Two ♀ ♀ from the southern states and one ♂ from Alaska. The type and one co-type, both from the southern states, must be referred to *L. pilatei* Hough. The ♂ from Alaska agrees with *L. caesar* Linn. in everything except the width of front which appears to be very slightly greater than in *L. caesar*. This, however, is probably partly optical, as the inner margins of the eyes, in the region of the ocellar triangle, are blackish, and thus appear to be part of the front.

Lucilia infuscata. Town.

From the description (Townsend. Taxonomy of Muscoidean Flies, p. 123) it is evident that the ♂ ♂ are *L. caesar* Linn. as all the characters enumerated come within the limits of variation of that species.

The ♀ ♀ of which there are six, "can be told from *caesar* only by the narrower front and darker basal segment." As to the latter of these characters the study in variation for *L. caesar* brought out the fact that in that species the first segment

of the abdomen is not unicolorous with the other segments, but darker. As to the former character, i. e., the 'narrower front,' the more general condition met with in *caesar* as to width of front is less than one third head width, or to be more specific three tenths head width; *infusata* is described as having the front two-sevenths head width and the difference between three-tenths and two-sevenths is one-seventieth, which reduces the character as a differentiating one to an absurdity.

An examination of the type and co-type bears out the above remarks and proves the form to be *L. caesar* Linn. with the exception of one co-type which is *Phormia regina* Meig.

Lucilia oculata. Town.

Six ♂♂ and two ♀♀. The former are *L. caesar* Linn. and the latter are *L. pilatei* Hough. The author of *oculata* lays stress on the color of the face and antennae, which are described in this instance as brownish yellow instead of black. After examining the U. S. N. Museum *caesar* material the writer found that taking three specimens from England, one from Mexico and one from Connecticut an excellent gradational series could be made, showing transition from black to light reddish brown. In this connection it may be stated that the late Mr. D. W. Coquillett collected a specimen of *L. pilatei* Hough, in Washington, D. C., which exhibits some remarkable colorational features. The whole fly is quite light, especially the legs and venter, but it is distinctly 'shot' with green and blue, so that in different lights it takes on different colors; the parafacials are pale reddish yellow. It is the experience of the writer that, within certain limits, the earlier a specimen of *Lucilia* is captured after issuance the lighter will be the color.

The synonymy indicated in the above notes on the types and co-types of *Lucilia* species in the U. S. N. Museum may be listed as follows;

- Lucilia morilli* Town = *Pseudopyrrillia cornicina*, Fab.
- Lucilia nigripalpis* Town = *Lucilia sylvarum*, Meig.
- Lucilia angustifrons* Town = *Lucilia caesar*, Linn. (abnormal fly).
- Lucilia giraulti* Town = *Lucilia sericata* Meig.
- Lucilia barberi* Town = *Lucilia sericata* Meig.
- Lucilia unicolor* Town = *Lucilia caesar* Linn.
- Lucilia purpurea* Town = *Lucilia caesar* Linn.
- Lucilia australis* Town = *Lucilia caesar* Linn.
- Lucilia infusata* Town = *Lucilia caesar* Linn.
- Lucilia infusata* Town = (1 cotype) = *Phormia regina* Meig.
- Lucilia oculata* Town, male = *Lucilia caesar* Linn.
- Lucilia oculata* Town, female = *Lucilia pilatei*, Hough.

It may be stated that Mr. W. R. Thompson and the late Mr. D. W. Coquillett examined independently the above material and both gentlemen substantially confirmed the above synonymy. Before leaving the subject of synonymy the opportunity may be taken of making a few remarks on some species listed in Aldrich's catalogue of North American Diptera. As regards *Lucilia sylphida*, Bigot, a copy of the original description (Ann. Soc. Ent. de France 1877, p. 45, which was furnished the writer through the courtesy of Prof. J. M. Aldrich, is as follows:

"17. *S. Sylphida* female (nov. sp?).

Viridi metallico. (Abdomen?) Antenn. segmento 3.0 secundo quadruplo longiore. Alis, vena 4a usque ad apicem primæ spinosa. Clavus subhumerali nigra. Facie, basi tantum, duobus macrochactis muris. Antennais palpisque pallide testaceis. Fronte grisea, occipite utrinque obscure aenescante, vitta nigra apice fulva, facie albida, genis pallidissime testaceis; calyptris albis; alis hyalinis basi, pallidissime testaceis; pedibus, fusco-nigra, femoribus, extrinsecus, parum aeneis. (L'abdomen manquant, est ce bien une espèce nouvelle?)"

In this brief description mention is made of none but generic characters and these in a most general way. The form is probably not a distinct species, but this can only be ascertained by an examination of the type. As to some of the other species:

Lucilia mollis, Walk.

Hough refers doubtfully to *Phormia regina*.

Lucilia rufipalpis, Jaen.

Hough refers to *Phormia regina*.

Lucilia nobilis, Meig.

Mr. Austen, of the British Museum writes that this form is now generally considered to be synonymous with *L. sericata*.

Lucilia sylphida, Big.

Probably not a distinct form.

Lucilia terræ-novæ, Des.

Hough refers to *Phormia*.

OBSERVATIONS ON THE CHÆTOTAXY OF CALLIPHORINÆ.*

BY PHINEAS W. WHITING.

LUCILIA.

In his "Synopsis of the Calliphorinæ (Diptera) of the United States" (Zool. Bull. 1899, Vol. II, No. 6), Garry de Neuville Hough defines our species of *Lucilia* as follows:

- Three postacrosticals. Front of male linear, of female one-third as wide as the head; abdomen unicolorous. *casar* L.
- Front of male not linear, at narrowest part about one-eighth as wide as the head; front of female about one-fourth as wide as the head; abdomen not unicolorous, first segment and hind margins of second and third blackish, contrasting strongly with the remainder. *pilator* nov. sp. [Hough]
- Three postacrostalis. Palpi black; front of male very narrow, that of female about one-third as wide as the head; abdomen with two stout marginal macrochaetae on the second abdominal segment. *sylvator* Meig.
- Palpi yellow; front of male varies from one-eighth to one-sixth as wide as the head, that of female about one-third as wide as the head; second abdominal segment without marginal macrochaeta. *sericata* Meig."

Moreover, he says, "The chaetotaxy is invariable for each species except for an occasional evident deformity, and it differs in the different species only in the number of achrostical bristles."

Observations were made on this subfamily during the past season and especial attention was given to the matter of chaetotaxy in *Lucilia*. Thus some estimate may be obtained of the extent of deformity as it occurs in nature. Female flies of this genus, moreover, were obtained alive and set in cages containing fish, in order that their offspring might be obtained for the purpose of studying the range of variation in the progeny of the separate females. Each family probably represents the offspring of several males as copulation is frequent. The bristles studied comprise only the achrosticals and the dorso-centrals posterior to the transverse suture of the thorax, with the exception that in *L. sylvator* the marginal bristles on the second abdominal segment were recorded as they showed considerable divergence from the normal condition recorded by Hough and are regarded as a specific character.

*Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 67.

The post-sutural dorso-centrals and achrosticals in *L. sericata* form a group of twelve in four rows of three each as shown in the diagram (Fig. 1). This arrangement is recorded as 3, 3, 3, 3, the separation into rows being denoted by commas.

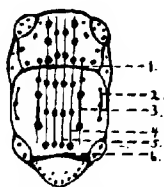


Fig. 1. Thorax of *Calliphora viridescens* to show typical arrangement of post-sutural bristles.
1. Transverse suture. 2. Supra-alar bristles.
3. Intra-alar bristles. 4. Dorso-central bristles.
5. Post-achrostical bristles. 6. Scutellar suture.

When one or two of the anterior bristles of a row are omitted, the row is denoted by 2 or 1 respectively.

In order to denote the omission of the second or third bristle when those anterior to it are not omitted, the normal positions of the bristles are recorded as a, b, and c, from anterior to posterior. Thus a row lacking the second bristle would be called ac.

Addition of a supernumerary bristle into a row is denoted by ! inserted in the proper position between or in front of the letters denoting the normal bristles. Thus addition of a bristle in front of a row would be expressed by calling the row !abe. But in some cases the number of bristles alone was recorded for each row and the row was called 4 or 5, according to whether one or two bristles were added.

Insertion of a supernumerary bristle between the normal rows is denoted by parentheses enclosing a, b, or c, according to the position of the bristle from anterior to posterior. Thus a definition as 3, (a), 3, 3, 3, would denote the addition of a bristle between the first left post-dorso-central and the first left post-achrostical.

Additional bristles are usually smaller than the normal, but range all the way from microchaetæ to the size of the normal macrochaetæ. A small bristle is denoted by italics.

The records of wild flies are first noted, and these are followed by an account of the breeding experiments.

On July 29 the following were taken at meat near the Bussey Institution, Forest Hills, Mass.

<i>L. sericata</i> :	277 individuals—3, 3, 3, 3.	1 ♂ —3, 3, ab, 3.
	1 ♀ —5, 3, 3, 4.	1 ♀ —3, 2, 2, 1.
	4 ♀ ♀—3, 2, 2, 3.	2 ♀ ♀—3, 3, 2, 3.
	2 ♀ ♀—3, 3, 3, 4.	1 ♀ —3, 1, 3, 3.
	1 ♀ —3, 3, 4, 3.	1 ♂ —3, 2, 3, 3.

The frequent lack of anterior post-achrosticals either on one or on both sides is interesting as it denotes approach toward *L. caesar*. The general habitus, however, is typical *sericata*. A single specimen of *caesar* taken in this lot was 3, abe, abe, 3. Thus it appears that chaetotaxy alone cannot be relied upon to determine the species with certainty. This will appear from the following observations and even more clearly from the breeding experiments.

On Aug. 5, at meat at Bussey Institution, were taken:

<i>L. sericata</i> :	311 individuals—3, 3, 3, 3.	1 ♂ —3, ac, 3, 3.
	1 ♂ —3, 3, 2, 3.	1 ♀ —3, 3, 2, 3.
	1 ♀ —3, 3, ac, 3.	

L. caesar:

1 ♀ —3, 2, 2, 3.

L. sylvarum: 1 ♀ —3, 3, 3, 3, with two bristles on margin of second abdominal segment (for brevity written 2 ab. br.)

On Aug. 6, at meat at Bussey Institution, were taken:

<i>L. sericata</i> :	68—3, 3, 3, 3.	1 ♂ —3, 2, 3, 3.
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On Aug. 8, at the garbage scow, Boston, were taken at meat:

<i>L. sericata</i> :	955 individuals—3, 3, 3, 3.	1 ♂ —3, 3, ac, 3.
	1 ♂ —3, ac, 3, 3.	1 ♂ —3, 3, 2, 3.
	2 ♂ ♂—3, ab ! c, 3, 3.	1 ♀ —3, abc, 3, 3.
	1 ♀ —3, 1, 2, 3.	1 ♀ —3, ac, ac, 3.
	1 ♀ —3, 3, 3, 4.	1 ♀ —3, 3, 4, 4.
	1 ♀ —3, 4, 3, 3.	1 ♀ —3, 2, 1, 3.
	5 ♀ ♀—3, ac, 3, 3.	2 ♀ ♀—3, abc, 3, 3.
	3 ♀ ♀—3, 3, ac, 3.	3 ♀ ♀—3, 3, 2, 3.
	4 ♀ ♀—3, 2, 3, 3.	

Flies having the habitus of *caesar* were as follows:

5 ♂ ♂—3, 2, 2, 3.	9 ♀ ♀—3, 2, 2, 3.
1 ♀ —3, abc, 2, 3.	

On Aug. 9 at a short distance from Bussey Institution on leaves near a pond the following were taken:

<i>L. sericata</i> :	1 ♂ —3, 3, 3, 3.
<i>L. caesar</i> :	1 ♀ —3, 2, 2, 3.
<i>L. sylvarum</i> :	2 ♂ ♂—3, 3, 3, 3, with 2 ab. br.
	1 ♂ —3, 3, 2, 3, with 2 ab. br.
	4 ♀ ♀—3, 3, 3, 3, ab. br. lacking.

On Aug. 10 at same place the following were taken at meat:

<i>L. sericata</i> :	4 ♂ ♂—3, 3, 3, 3.	100 ♀ ♀—3, 3, 3, 3.
	2 ♀ ♀—3, 2, 2, 3.	2 ♀ ♀—3, a / bc, 3, 3.
	1 ♀ —3, (a), 3, 3, 3.	
<i>L. caesar</i> :	3 ♂ ♂—3, 2, 2, 3.	20 ♀ ♀—3, 2, 2, 3.
<i>L. sylvarum</i> :	1 ♂ —3, 3, 3, 3, with 2 ab. br.	
	1 ♀ —3, 3, 3, 3, with 2 ab. br.	

An indeterminate ♂ *Lucilia*—3, abc, abc, 3.

On Aug. 12, at same place on leaves were taken:

- L. sericata*: 1 ♀ —3, 3, 3, 3.
L. sylvarum: 14 ♂♂—3, 3, 3, 3, with 2 ab. br.
 2 ♂♂—3, 3, 3, 3, with 3 ab. br.
 1 ♂ —3, 3, 3, 3, with 4 ab. br.
 1 ♂ —3, 3, a / bc, 3, with 2 ab. br.
 1 ♀ —3, 3, a / bc, 3, with 2 weak ab. br.

On Aug. 14, at same place, on leaves were taken:

- L. sericata*: 1 ♀ —3, 3, 3, 3.
L. casar: 4 ♀♀—3, 2, 2, 3.
L. sylvarum: 5 ♂♂—3, 3, 3, 3, with 2 ab. br.
 1 ♂ —3, 3, 2, 3, with 3 ab. br.
 2 ♂♂—3, 3, 3, 3, with 4 ab. br.
 1 ♂ —3, a / bc, ab / c, 3, with 2 ab. br.
 3 ♀♀—3, 3, 3, 3, ab. br. lacking.

And at meat:

- L. casar*: 2 ♂♂—3, 2, 2, 3.
 21 ♀♀—3, 2, 2, 3.
L. sericata: 6 ♂♂—3, 3, 3, 3.
 225 ♀♀—3, 3, 3, 3.
 1 ♀ —3, 3, 3, / abc.
 2 ♀♀—3, a / bc, 3, 3.
 1 ♀ —3, 3, a / bc, 3.
 1 ♀ —3, ac, 3, 3.
L. sylvarum: 1 ♀ —3, 3, / abc, 3, with 2 weak ab. br.

On Aug. 15, in meadow near Bussey Institution were taken at meat:

- L. casar*: 1 ♂ —3, 2, 2, 3.
L. sericata: 8 ♂♂—3, 3, 3, 3.
 145 ♀♀—3, 3, 3, 3.
 1 ♀ —3, 3, 3, / abc.
 1 ♀ —3, a / bc, 3, 3.
 1 ♀ —a / bc, 3, 3, 3.
 1 ♀ —3, 3, a / bc, 3.

On Aug. 20, at Hartland, Vt., by the bank of the Connecticut River at some distance from any house were taken at meat:

- L. casar*: 1 ♂ —3, 2, 2, 3. 32 ♀♀—3, 2, 2, 3.
 1 ♀ —3, 3, 2, 3.
L. sylvarum: 3 ♀♀—3, 3, 3, 3, with 2 well developed ab. br.

On Oct. 17, at garbage scow, Boston, were taken at meat:

- L. sericata*: 28 ♂♂—3, 3, 3, 3. 351 ♀♀—3, 3, 3, 3.
 1 ♂ —3, 2, 2, 3. 1 ♂ —3, 3, 2, 3.
 1 ♀ —3, 2, 2, 3. 1 ♀ —3, 3, 2, 3.
 1 ♀ —3, 2, abc, 3. 1 ♀ —3, 3, ac, 3.
 1 ♀ —3, ac, ac, 3. 1 ♀ —3, 3, 3, ab / c.
 1 ♀ —/ abc, 3, 3, / abc.

In all cases habitus rather than chaetotaxy has been taken as the criterion of specific determination, and this I believe to be more reliable on account of my breeding experiments. By habitus I mean general coloration and slight differences of form which would be very hard to define verbally. The width of the front is also important here. The habits are also somewhat different, as may be seen from the observations. *L. sylvarum* appears to be the wildest form, being without excep-

flies taken at some distance from buildings. *Sericata* is more commonly present either inside or very near buildings, while *caesar* may be taken in either situation, but more frequently along with *sylvanum*. It would be of considerable interest to study the distribution of these species over a more extensive area.

In order to get an approximate estimation of the percentage of individuals abnormal in chaetotaxy, I have added the sericatas and find them as follows:

Normal—2,479 individuals. Abnormal by reduction 47 individuals or 2%. Abnormal by addition 23 individuals or 1%. Abnormal by reduction and addition 1 ♂—3, 2, 2, 4, or .04%.

The variants by reduction are here 10 ♂♂ and 37 ♀♀, while the variants by addition are 2 ♂♂ and 22 ♀♀. The excess of females is of course due to the fact that the flies were taken at meat.

Some of the flies were bred to show the character of the progeny, and these showed results as follows:

L. sylvanum: ♀—3, 3, a / bc, 3, with 2 very small ab. br., taken by pond near Bussey, Aug. 12, gave all females in progeny as follows:
 9 ♀♀—3, 3, 3, 3, ab. br. lacking.
 2 ♀♀—3, 3, 3, 3, with 2 small ab. br.
 1 ♀—3, / abc, 3, 3, ab. br. lacking.
 3 ♀♀—3, 3, a / bc, 3, ab. br. lacking.
 1 ♀—3, / abc, / abc, 3, ab. br. lacking.

This suggests that an extra post-sutural bristle may be inherited.

L. caesar:
 ♀—3, 2, 2, 3, from Bussey Pond, Aug. 14, gave 18 ♂♂—3, 2, 2, 3.
 13 ♀♀—3, 2, 2, 3. 1 ♂—3, b, 2, 3.
 2—3, 2, 2, 3, from Bussey Pond, Aug. 10, gave 13 ♂♂—3, 2, 2, 3. No males.

L. sericata:
 ♀—3, 3, 3, 3, from Bussey Institution, July, gave
 51 ♂♂—3, 3, 3, 3.
 35 ♀♀—3, 3, 3, 3. 1 ♀—3, 3, a / bc, 3.
 ♀—3, 3, 3, 3, from Bussey Institution, Aug. 5, gave
 71 ♂♂—3, 3, 3, 3. 59 ♀♀—3, 3, 3, 3.
 3 ♂♂—3, 3, a / bc, 3. 2 ♂♂—3, a / bc, 3, 3.
 1 ♂—3, a / bc, a / bc, 3. 1 ♀—3, a / bc, 3, 3.
 1 ♀—3, 3, a / bc, 3.
 ♀—3, 3, 3, 3, from Bussey Institution, July, gave
 32 ♂♂—3, 3, 3, 3. 32 ♀♀—3, 3, 3, 3.
 3 ♀♀—/ abc, 3, 3, / abc.
 1 ♀—/ abc, / abc, 3, / abc.
 1 ♀—3, / abc, / a / bc, 3.
 1 ♀—/ abc, 3, 3, (a), 3.
 1 ♀—3, 3, / abc, 3. 1 ♂—3, 3, ac, 3.
 1 ♂—/ abc, 3, 3, / abc. 1 ♂—3, (c), 3, 3, 3.
 1 ♂—3, 3, 2, 3. 1 ♂—3, 3, 3, / abc.

- ♀-3, 3, 3, 3, from Bussey Institution, July, gave:
 78 ♂♂-3, 3, 3, 3.
 1 ♂ -3, 3, ab, 3.
 4 ♂♂-3, 2, 3, 3.
 1 ♂ -3, (a), 3, 3, 3.
 1 ♀ -3, 3, ac, 3.
 1 ♀ -! abc, 3, 3, ! abc.
 1 ♀ -3, a ! bc, 3, 3.
 110 ♀♀-3, 3, 3, 3.
 1 ♂ -3, 2, ac, 3.
 1 ♂ -3, 2, 2, 3.
 1 ♂ -3, a ! bc, a ! bc, 3.
 1 ♀ -3, 3, 3, ! abc.
 1 ♀ -! abc, 3, 3, 3.
 ♀-3, 3, 3, 3, from Bussey, July, gave:*
 30 ♂♂-3, 3, 3, 3.
 1 ♂ -3, ac, 3, 3.
 2 ♀♀-3, 3, 3, 3, taken at Bussey Institution, gave:
 191 ♂♂-3, 3, 3, 3.
 2 ♂♂-3, ac, 3, 3.
 2 ♂♂-3, 3, 2, 3.
 1 ♂ -3, 3, ac, 3.
 1 ♂ -3, ac, 2, 3.
 203 ♀♀-3, 3, 3, 3.
 3 ♂♂-3, 2, 3, 3.
 1 ♂ -3, ab, 3, 3.
 1 ♀ -3, 2, 2, 3.
 1 ♀-3, 3, 3, 3, from Bussey Institution, Nov. 20, gave:
 124 ♂♂-3, 3, 3, 3.
 1 ♀ -3, 3, 2, 3.
 1 ♂ -3, ac, 3, 3.
 118 ♀♀-3, 3, 3, 3.
 1 ♂ -3, 2, 2, 3.
 1 ♀ -3, 3, 3, 3, from Bussey Institution, Nov. 18, gave:
 25 ♂♂-3, 3, 3, 3.
 2 ♀♀-3, ac, 3.
 1 ♀ -3, a ! bc, 3, 3.
 34 ♀♀-3, 3, 3, 3.
 1 ♀ -3, ac, 3, 3.
 1 ♂ -a ! bc, 3, 3, 3.
 1 ♀-3, 3, 3, 3, from scow, Boston, Aug. 8, gave:
 17 ♂♂-3, 3, 3, 3.
 1 ♀ -3, 3, a ! bc, 3.
 19 ♀♀-3, 3, 3, 3.

Thus the progeny of normal ♀♀ (3, 3, 3, 3.) show considerable variation, and it is readily observed that this variation tends in some cases to reduction of bristles, in other cases to addition of bristles, while both tendencies may be observed in the same family. Taking the totals of these families we have normal ♂♂ 589, normal ♀♀ 410, variants by addition, 12 ♂♂ and 16 ♀♀; and variants by reduction, 21 ♂♂ and 6 ♀♀. This gives 2.6% variants by addition and 2.5% variants by reduction.

Let us now consider the families of *L. sericata* produced by mothers abnormal by reduction.

- ♂ and ♀-3, 3, 2, 3, taken at scow, Boston, Oct. 17, put in same box, gave:
 13 ♂♂-3, 3, 3, 3.
 1 ♂ -3, 3, 2, 3.
 1 ♂ -3, ac, ac, 3.
 * 2 ♀♀-3, 2, 3, 3.
 8 ♀♀-3, 3, 3, 3.
 1 ♂ -3, ac, 3, 3.
 1 ♂ -3, 3, 2, 3.
 ♀-3, 2, 3, 3, taken at scow, Boston, Aug. 8, gave:
 32 ♂♂-3, 3, 3, 3.
 1 ♂ -3, ac, 3, 3.
 1 ♂ -3, 3, ab, 3.
 1 ♂ -3, ac, 2, 3.
 22 ♀♀-3, 3, 3, 3.
 1 ♂ -3, 3, ac, 3.
 1 ♂ -3, 2, 3, 3.

*By reason of an imperfection in the technique at this point, this culture may have been contaminated from flies outside. The results are therefore, not averaged in with the total.

- ♀-3, 3, ac, 3, from scow, Boston, Aug. 8, gave 12 ♂♂-3, 3, 3, 3.
 15 ♀♀-3, 3, 3, 3.
 ♀-3, ac, 2, 3, from Bussey Institution, July, gave:
 18 ♂♂-3, 3, 3, 3. 8 ♀♀-3, 3, 3, 3.
 ♀-3, 2, 3, 3, from scow, Boston, Aug. 8, gave:
 10 ♂♂-3, 3, 3, 3. 14 ♀♀-3, 3, 3, 3.
 1 ♂-3, 3, 2, 3. 1 ♂-3, ac, 3, 3.
 1 ♀-3, ac, ac, 3.
 ♀-3, 2, 1, 3, from scow, Boston, Aug. 8, gave 10 ♂♂-3, 3, 3, 3. 12 ♀♀-3, 3, 3, 3. This family was continued into the third generation and will be considered below.
 ♀-3, ac, 3, 3, from scow, Boston, Aug. 8, gave:
 7 ♂♂-3, 3, 3, 3. 7 ♀♀-3, 3, 3, 3.
 1 ♀-3, 3, a/bc, 3.

Taking the totals of these families of females deficient in bristles we find normal ♂♂ 102, normal ♀♀ 86, variants by reduction 10 ♂♂ and 4 ♀♀, variants by addition, 1 ♀. Thus from these rather small numbers we see the variants by reduction are 7%, while the variants by addition are 0.5%.

¶Let us consider now the progeny of females abnormal by addition of bristles.

- ♀-1 abc, 3, 3, 1 abc, from scow, Boston, Oct. 17, gave:
 30 ♂♂-3, 3, 3, 3. 21 ♀♀-3, 3, 3, 3.
 1 ♂-3, (a), 3, 3, (a), 3.
 ♀-3, 3, 3, ab/c, from scow, Boston, Oct. 17, gave:
 9 ♂♂-3, 3, 3, 3. 20 ♀♀-3, 3, 3, 3.
 1 ♂-3, 3, 3, (a), 3. 1 ♂-3, ac, 3, 3.
 1 ♀-3, ac, ac, 3.
 ♀-3, 3, a/bc, 1 abc, from scow, Boston, Aug. 8, gave:
 40 ♂♂-3, 3, 3, 3. 32 ♀♀-3, 3, 3, 3.
 3 ♂♂-3 a/bc, 3, 3. 1 ♂-3, 3, a/bc, 3.
 1 ♂-3, (a), 3, 3, 3. 1 ♂-3, ac, ac, 3.
 1 ♀-3, 3, a/bc, 3. 2 ♀♀-3, a/bc, 3, 3.
 1 ♀-3, 3, ac, 3. 1 ♀-3, ab, 3, 3.
 1 ♀-3, 3, 2, 3. 1 ♀-3, ac, 3, 3.
 ♀-a/bc, a/bc, 3, 3, from scow, Boston, Aug. 8, gave:
 75 ♂♂-3, 3, 3, 3. 52 ♀♀-3, 3, 3, 3.
 1 ♂-3, 3, a/bc, 3. 1 ♂-3 (a), 3, 3, 3.
 1 ♂-3, a/bc, 3, 3. 2 ♀♀-3, a/bc, 3, 3.
 2 ♀♀-3, 3, a/bc, 3. 1 ♀-3, 3, 3, a/bc.

Taking the totals of these families of females abnormal by addition of bristles we find normal ♂♂ 154, normal ♀♀ 125, variants by reduction, 2 ♂♂ and 5 ♀♀; variants by addition, 10 ♂♂ and 8 ♀♀. Thus the variants by reduction are 2.3% while the variants by addition are 6%.

From the averages of the reared stock we see there is a tendency to vary both toward reduction and toward addition of bristles and that this tendency is evidently of a hereditary character, the mean being shifted in the direction of the parental abnormality.

The female of *L. sericata* (3, 2, 1, 3.) taken at the garbage scow, Boston, August 8, gave as above recorded 10 ♂♂-3, 3, 3, 3, and 12 ♀♀-3, 3, 3, 3. Three pairs of these were segregated and gave offspring as follows:

1st pair gave:		
10 ♂♂-3, 3, 3, 3.		7 ♀♀-3, 3, 3, 3.
2d pair gave:		
42 ♂♂-3, 3, 3, 3.		39 ♀♀-3, 3, 3, 3.
1 ♂-ac, 3, 3, ac.		2 ♂♂-3, !abc, 3, 3.
1 ♂-3, 2, 3, 3.		1 ♀-3, ac, ac, 3.
1 ♀-3, ac, 3, 3.		
3d pair gave:		
55 ♂♂-3, 3, 3, 3.		62 ♀♀-3, 3, 3, 3.
7 ♂♂-3, 2, 2, 3.		1 ♀-3, 2, 2, 3.
2 ♂♂-3, 3, 2, 3.		3 ♀♀-3, 2, 3, 3.
1 ♂-3, 3, 3, ac.		1 ♀-3, abc, 3, 3.
1 ♂-3, a !bc, 3, 3.		1 ♀-3, abc, 2, 3.
1 ♀-2, 3, 3, 3.		1 ♀-3, 3, ac, 3.
1 ♀-3, ab, 3, 3.		

Of the progeny of the first pair 1 ♂-3, 3, 3, 3, was mated to 2 ♀♀-3, 3, 3, 3, and produced offspring as follows:

163 ♂♂-3, 3, 3, 3.	170 ♀♀-3, 3, 3, 3.
2 ♂♂-3, ac, 3, 3.	2 ♀♀-3, ac, 3, 3.
2 ♂♂-3, 3, ac, 3.	1 ♀-2, 3, 3, 3.
1 ♂-3, 3, 2, 3.	1 ♀-ac, 3, 3, 2.
1 ♂-With very few scattered bristles.	1 ♀-ac, 3, 2, 0.
1 ♂-3, a !bc, 3, 3.	1 ♀-ab, 3, ab, bc.
1 ♂-3, 3, a !bc, 3.	2 ♀♀-3, a !bc, 3, 3.
1 ♀-3, 3, a !bc, 3.	2 ♀♀-3, 3, a !bc, 3.
1 ♀-a !bc, 3, 3, 3.	1 ♀-!abc, 3, 3, !abc.

Of the progeny of the second pair 1 ♂-3, 3, 3, 3, was mated to 1 ♀-3, 3, 3, 3, and produced the following:

92 ♂♂-3, 3, 3, 3.	85 ♀♀-3, 3, 3, 3.
2 ♂♂-3, a !bc, a !bc, 3.	5 ♂♂-3, a !bc, 3, 3.
4 ♂♂-3, 3, a !bc, 3.	3 ♀♀-3, a !bc, 3, 3.
1 ♀-3, 3, a !bc, 3.	1 ♀-3, ac, 3, 3.

If we take the totals of this inbred stock we find them as follows:

362 ♂♂-3, 3, 3, 3.	363 ♀♀-3, 3, 3, 3.
By reduction, 18 ♂♂ and 18 ♀♀ or 5%.	
By addition, 16 ♂♂ and 11 ♀♀ or 3.7%.	

In the spring of 1912 a few specimens of *Calliphora vomitoria* L. and *C. viridescens* Desv. were taken at Cambridge and *C. erythrocephala* Meig was common all through the summer. In the fall *vomitoria* and *viridescens* appeared in considerable numbers in the vicinity of the Bussey Institution. The

records of chaetotaxy of the wild *Calliphorae* that was taken at Bussey are as follows. The bristles observed are the post-achrosticals and post-dorso-centrals as in *Lucilia*.

<i>C. erythrocephala</i> :	
33 ♂♂—3, 3, 3, 3.	134 ♀♀—3, 3, 3, 3.
1 ♀—3, 3, a ! bc, 3.	1 ♀—2, 3, 3, 3.
<i>C. vomitoria</i> :	
2 ♂♂—3, 3, 3, 3.	54 ♀♀—3, 3, 3, 3.
<i>C. viridescens</i> :	
21 ♀♀—3, 3, 3, 3.	1 ♀—3, ab, 3, 3.

These records show 3 abnormal males out of 247, but the ratio is not very significant as the numbers are very small.

The records of breeding *Calliphorae* show rather interesting results.

A ♀ <i>erythrocephala</i> —3, 3, 3, 3, gave:	
54 ♂♂—3, 3, 3, 3.	47 ♀♀—3, 3, 3, 3.
2 ♂♂—3, a ! bc, 3, 3.	

One of these abnormal males was mated to his sister and the pair gave the following offspring:

131 ♂♂—3, 3, 3, 3.	86 ♀♀—3, 3, 3, 3.
1 ♂—3, (a), 3, 3, 3.	1 ♀—3, a ! bc, aabc, 3.
4 ♂♂—3, a ! bc, 3, 3.	5 ♀♀—3, 3, a ! bc, 3.
1 ♂—3, a ! bc, a ! bc, 3.	1 ♀—3, 3, 3, ab.
8 ♂♂—3, 3, a ! bc, 3.	
1 ♂—3, ab, 3, 3.	

Another wild ♀ <i>erythrocephala</i> —3, 3, 3, 3, gave:	
80 ♂♂—3, 3, 3, 3.	74 ♀♀—3, 3, 3, 3.

Another wild ♀ <i>erythrocephala</i> —3, 3, 3, 3, gave:	
97 ♂♂—3, 3, 3, 3.	97 ♀♀—3, 3, 3, 3.
	2 ♀♀—3, 3, ac, 3.

A ♀ <i>vomitoria</i> —3, 3, 3, 5, gave:	
47 ♂♂—3, 3, 3, 3.	61 ♀♀—3, 3, 3, 3.
4 ♂♂—3, ac, 3, 3.	1 ♀♀—3, ac, 3, 3.
2 ♂♂—3, 3, ac, 3.	4 ♀♀—3, 3, ac, 3.
1 ♂—3, 3, ab, 3.	1 ♀—3, 2, 3, 3.
1 ♂—3, 3, 2, 3.	

Another ♀ <i>vomitoria</i> —3, 3, 3, 3, gave:	
32 ♂♂—3, 3, 3, 3.	61 ♀♀—3, 3, 3, 3.
1 ♂—3, ab, 3, 3, 3.	2 ♂♂—3, a ! bc, 3, 3.
1 ♂—3, 2, 3, 3.	1 ♀—3, a ! bc, a ! bc, 3.
1 ♂—3, 2, 2, 3.	

A ♀ <i>viridescens</i> —3, 3, 3, 3, gave:	
5 ♂♂—3, 3, 3, 3.	5 ♀♀—3, 3, 3, 3.
1 ♂—3, 2, 3, 3.	1 ♀—3, ac, 3, 3.

Another ♀ <i>viridescens</i> —3, ab, 3, 3, gave:	
4 ♂♂—3, 3, 3, 3.	6 ♀♀—3, 3, 3, 3.
1 ♂—3, ac, 3, 3.	

The totals of the bred stock for the three species are:

450 ♂♂—3, 3, 3, 3.	413 ♀♀—3, 3, 3, 3.
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By reduction 14 ♂♂ and 4 ♀♀, or 2%; by addition 18 ♂♂ and 12 ♀♀ or 3%.

In the course of collecting *Calliphoræ* four specimens were obtained which I was unable to classify as belonging to any one of the three species common in Massachusetts. They appeared like inter-grades between *erythrocephala* and *viridescens*.

One small sized male had the beard black, the right cheek dark red, and the left cheek somewhat lighter in color. The right cheek was dark enough to place the specimen as *viridescens* but the left cheek resembled that of *erythrocephala*. One small and two large sized females answer also to the same description. In all four cases the right cheek is considerably darker than the left. The flies were examined by Mr. C. W. Johnson who was unable to classify them.

The meaning of these forms is uncertain and I should not feel justified in advancing an hypothesis without first performing breeding experiments with them.

SUMMARY AND CONCLUSIONS.

A number of meat flies of the *Calliphorine* genera, *Lucilia* and *Calliphora*, were collected during the summer and fall of 1912 and observations were made on the range of variation in the chaetotaxy. The bristles studied were the post-sutural achrosticals and dorso-centrals of the thorax. Breeding experiments were also performed in order to study the range of variation in the individual families.

Especial attention was given to *Lucilia sericata*. The following table gives the general results of the work on this species.

	Normal		Abnormal by reduct'n				Abnormal by addition			
	2,479		Number		Percentage		Number		Percentage	
Wild Flies Captured			47		2		23		1	
	♂♂	♀♀	♂♂	♀♀			♂♂	♀♀		
Progeny of normal ♀♀	589	410	21	6	2.5		12	16	2.6	
Progeny of ♀♀ abnormal by reduction	102	86	10	4	7		0	1	0.5	
Progeny of ♀♀ abnormal by addition	154	125	2	5	2.3		10	8	6	

As regards the wild flies captured it will be observed that there are twice as many abnormal by reduction as there are abnormal by addition. Too much importance should not be attached to this fact, as it may be due to an error. In a few cases there is reduction in the size of the bristle normally present, but as a general thing there is no reduction unless the bristle is entirely absent. On the other hand a very small bristle is frequently added and it is more rarely the case that a supernumerary bristle is of the full size. In looking over a large number of flies rapidly, one would then have a tendency to overlook the presence of the small additional bristle and to record more reduction than addition in number. As these flies were examined for the purpose of finding breeding material, careful attention was not given to this matter and I am inclined to consider the normal range of variation to be somewhat above two per cent both in the direction of reduction and in the direction of addition. This equality of variation in both directions is seen in the progeny of normal females. In the progeny of females abnormal by reduction and of females abnormal by addition, the variation of the offspring is seen to tend in the direction of the parental abnormality.

A single female lacking three bristles, (3, 2, 1, 3), gave ten males and twelve females of normal chaetotaxy. Three pairs of these gave 215 normal flies, 23 abnormal by reduction, and 3 abnormal by addition. A pair and a trio of these normals gave in the third generation from the original female, 510 normals, 13 abnormal by reduction, and 24 abnormal by addition. This shows regression away from the abnormal and suggests Galton's Law.

Observations made on *Lucilia sylvarum* and *caesar*, and on *Calliphora erythrocephala*, *viridescens*, and *vomitoria* lead me to believe that these five species are analogous to *Lucilia sericata* in the variation of their chaetotaxy.

In conclusion I wish to express my thanks for suggestions and criticism in the course of the work kindly offered by Professor Wheeler, Professor Castle and Mr. Brues.

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A REVISION OF THE SPECIES IN *AGROMYZA* FALLEN,
AND *CERODONTA* RONDANI. (DIPTERA).

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The work on the two genera presented in this paper has been undertaken for the purpose of deciding the identity and distinctions of several species affecting field and forage crops, upon which considerable work has been done by the field agents of the division dealing with the insects affecting these crops. In some cases it has been found necessary to change the names of certain American species, as examination has proved that they are either synonymous with other American species or with species belonging to the European fauna. In the case of some other species it may at some future time become necessary to sink the American species as synonymous with European forms, but owing to the most unsatisfactory condition of the knowledge of the species contained in this family (*Agromyzidae*) in Europe, it is not possible to definitely decide upon the correct names of their species from the brief descriptions available. Thus, while I suspect the distinctness of certain species in our fauna from others occurring in Europe, I consider it the safer plan, and one entailing no material disadvantages, to retain those species in our list, rather than rank them as synonyms of species which may ultimately prove to be absent from our fauna.

Generic Characters of *Agromyzæ*.

Head of normal size; frons broad, from one-third to a little over one-half the head width; ocelli on a slightly raised portion of the ocellar triangle, so distinct in the *Oscinidæ*, seldom transverse; orbits distinct, 3-5 pairs of orbital bristles present anterior to front ocellus; one pair of bristles on ocellar region slightly behind anterior ocellus, pointing forward and slightly divergent, vertical row consisting of two central divergent and two outer convergent bristles; postvertical bristles divergent; face nearly straight in vertical outline, or slightly concave, slightly keeled in center, or unkeeled; mouth margin not produced; antennæ of moderate size, or third joint enlarged, but never elongate or produced at apex; second joint with at least one dorsal setula; arista bare or pubescent, never plumose; cheeks linear or broadened posteriorly, sometimes one-half as high as eye, bristles confined to margin, vibrissa generally noticeably differentiated; proboscis membranous, not elongated noticeably nor geniculate; palpi normal. Mesonotum with 2-4 pairs of dorso-centrals; mesopleuræ with 1-3 long posterior bristles as well as generally a number of setulæ; one or two bristles above mid coxæ and generally numerous setulæ; propleural bristle strong; squamæ distinct. Ovipositor of female generally with base chitinized, apex seldom protruding; male hypopygium of moderate size, not incurved. Legs without preapical bristle on dorsal surface; end spurs weak. Wings with subcostal vein weak, sometimes incomplete, but generally complete and ending very near to first vein, or fused with first at near apex; costa at end of subcosta uninterrupted, or only slightly so; costal vein with very short hairs which are, with exception of two slightly more distinct at end of subcosta, of almost equal length to beyond middle of wing; cross veins near to wing base, or the outer one at, or slightly beyond, wing middle; posterior basal cell always complete though small; anal vein (sixth) distinct; costa to third vein, slightly beyond it, or to fourth. This last character is difficult to distinguish sometimes, and is not of sufficient importance to permit of the relegation of those species having costa to only third vein, to a different genus from those with costa to fourth.

Synopsis Table of Species in *Agromyza*.

1. Halteres white or pale yellow; (*maculosa* has a black spot on outer disk)..... 2
Halteres black or brown, never pale yellow..... 10
2. Species with the disk of scutellum entirely or partly pale yellow..... 3
Species with disk of scutellum colored as mesonotum, and never in part pale yellow..... 11
3. At least the apical joint of antennae black..... 4
Antennae entirely yellow, or third joint only slightly infuscated..... 5
4. Frons black, only the frontal lunule yellow..... 1. *anthrophora* S. Chet.
Frons yellow, only the ocellar triangle black, and sometimes the posterior part of orbits darkened..... 2. *longispinosa*, new species
5. No short setulae on disk of mesonotum between the dorso-central bristles..... 6
6. Mesonotum with the disk broadly black, only the lateral margins broadly and the anterior and posterior margins yellow..... 7
Mesonotum with black, stripe-like marks, or disk black, the center of disk in front of scutellum yellow, owing to the abbreviation of central stripes..... 8
7. Third antennal joint and palpi, at apices, infuscated..... 2a. *variata*, new species
Third antennal joint and palpi entirely yellow..... 7a
- 7a. Mesonotum bare except for the dorso-central bristles..... 3 *disalis*, new species
Mesonotum with discal setulae in addition to dorso-centrals..... 7b
- 7b. Smaller species, 1-1.75 mm., last section of fifth vein $2\frac{1}{2}$ to 3 times as long as the penultimate section..... 4 *pavilla* Meigen
Larger species, 2-2.5 mm., last section of fifth vein $1\frac{1}{2}$ to 2 times as long as penultimate section..... 5 *scutellata* Fallen
8. Only the margins of the discal marks on mesonotum black, the center portions reddish brown..... 8 *melampyga* var. *marginalis*, new variety
Markings on mesonotum unicolorous throughout..... 9
9. Markings on mesonotum dull gray black, not glossy..... 6 *horealis*, new species
Markings on mesonotum glossy black..... 10
10. Cheeks, posteriorly, about one-half the eye height; arista almost bare..... 7 *flavonigra* Coquillett
Cheeks, posteriorly, much less than one-half the eye height; arista pubescent..... 8 *melampyga* Loew
11. Costa reaching to third vein or slightly beyond..... 12
Costa reaching to fourth vein..... 17
12. Frons lemon yellow; cross veins very close together..... 13
Frons reddish or black, never pale yellow..... 11
13. Lateral margins of mesonotum broadly pale yellow; anterior two pair of dorso-centrals on mesonotum much weaker than the posterior two pair; the front pair not anterior to suture..... 9. *brevicauda*, new species
Lateral margins of mesonotum colored as disk; anterior two pair of dorso-centrals not much reduced in size, the front pair distinctly anterior to suture..... 10 *dactyl* Walton
14. Frons black; cross veins not close together..... 15
Frons reddish; cross veins close together..... 16
15. Pubescence on arista indistinct; occiput not projecting much on upper hind..... 11 *abbrehiata*, new species
Pubescence on arista distinct; occiput distinctly projecting on upper hind..... 12 *lincolnii*, new species
16. Slender, slightly shining, black species; mesonotum with four pair of dorso-central bristles..... 13 *particella* Coquillett
Robust, glossy black species; mesonotum with two pair of dorso-central bristles..... 11 *nitida*, new species
17. Frons entirely yellow, or at least the center stripe mostly yellow or reddish, or the orbits yellow posteriorly..... 18
Frons entirely black or brown, never yellow on any part; frontal lunule sometimes white dusted..... 27

18. Mesonotum opaque gray; center of disk between the rows of dorso-central bristles with a yellowish-brown, longitudinal vitta, which extends on to disk of scutellum; three pairs of orbital, and four pair of dorso-central bristles present.....15 *immaculata* Coquillett
Mesonotum shining, or, if opaque grayish there is no indication of a central brown vitta.....16
19. Antennae entirely yellow, or third joint only darkened at insertion of arista.....19
Antennae with at least the third joint black, or dark brown, never yellow.....20
20. Head, including antennae, clear lemon yellow, only ocellar region, orbits posteriorly, and back of head black, or brown; pleurae and legs brown yellow with black or brown marks; lateral margins of mesonotum brown.....16 *citrefrons*, new species
Frons and face mostly, or entirely, reddish yellow; lateral margins of mesonotum pale yellow, or black and concolorous with disk of mesonotum.....21
21. Five equally strong orbital bristles present; frons one-half as broad as each orbit; not differentiated from center stripe; mesonotum with four pair of dorso-centrals.....17 *pruinosa* Coquillett
Four orbital bristles present; orbits differentiated from center stripe.....22
22. Lateral margins of mesonotum pale yellow; wings narrow; outer cross vein before wing middle; last section of fourth vein three times as long as the two preceding sections together.....18 *indecisa*, new species
Lateral margins of mesonotum not pale yellow; wings broad; outer cross vein at near wing middle; last section of fourth vein twice as long as two preceding sections together.....19 *rufifrons* Coquillett
23. Lateral margins of mesonotum broadly pale yellow.....24
Lateral margins of mesonotum narrowly, or not at all, yellow, the pale color confined almost entirely to the suture, or to the extreme upper margin of the pleurae.....25
24. Frons with the center stripe clear yellow; orbits posteriorly, sometimes blackened; legs black, or brown, the knees never distinctly yellow.....20 *platyptera* Thomsen
Frons with the center stripe more or less blackened; legs with the knees distinctly pale yellow.....21 *coquillettii*, new species
25. Palpi yellow.....22 *longipennis* Loew
Palpi black.....26
26. Larger species—3-3½ mm.—dull gray-black in color; apices of femora and bases of tibiae narrowly yellow.....23 *coloradensis*, new species
Smaller species—1½-2 mm.—shining black in color; apical half of each femur yellow, tibiae brownish yellow.....24 *marginata* Loew
27. Mesonotum with four, or more, pairs of dorso-central bristles.....25
Mesonotum with two or three pairs of dorso-central bristles.....26
28. The pair of bristles between the posterior pair of dorso-central almost of equal strength with them; basal two joints of antennae, legs mostly pleurae, humeri, and abdomen reddish yellow; outer cross vein beyond wing middle.....25 *canadensis*, new species
The pair of bristles mentioned above much weaker than posterior dorso-centrals, or absent; much darker species; only sometimes a narrow stripe line on pleurae, knee joints more or less broadly, and posterior margins of abdominal segments narrowly yellow; or entire thorax, abdomen and legs black, cross vein generally at or before wing middle or very slightly beyond it.....26
29. Third antennal joint in male enlarged, subquadrate, thickly covered with short, silky pilosity; in female the third joint is smaller and not so noticeably pilose; frontal lunule distinct, whitish pollinose; center stripe of frons brownish.....26 *laterella* Zetterstedt
Third antennal joint normal in size in both sexes, and not noticeably pilose.....30

*Sometimes *longipennis* has the antennae yellowish, in which case the specimens will run down to *indecisa* when a comparison of the descriptions will be necessary.

30. Halteres pale yellow, with a black spot on outer side of knob; dorso-central bristles strong, anterior pairs almost as strong as posterior pairs; last section of fifth vein shorter than penultimate section. 27 *maculosa*, new species. 31
- Halteres without any dark spot on knob. 31
31. Outer cross vein at about the length of inner cross vein from that vein; third and fourth veins very distinctly divergent at apices. 28 *teutoni*, new species. 32
- Outer cross vein separated by a greater distance than inner cross vein from that vein; third and fourth veins slightly divergent at apices. 32
32. Small species, at most 2 mm., base of wing, including basal half of first vein, upper part of pleurae and mesopleural vertical suture narrowly, a small patch below base of wing, squamae, and fringe lemon yellow; general color shining black; outer cross vein below, or at very slightly beyond end of first vein. 29 *angulata* Loew. 33
- Species other than above in color, etc. 33
33. Larger species, 3 mm. and over, almost entirely black-brown; lower half of orbits rather closely set with hairs. 30 *setosa* Loew. 34
- Smaller species, about 2 mm., not so uniformly colored; lower half of orbits sparsely haired. 34
34. Rather robust species; wings broad; cheeks linear; tibiae and tarsi yellowish. 31 *isolata*, new species. 35
- More slender species; wings narrow; cheeks one-fourth as high posteriorly as height of eyes; tibiae and tarsi barely paler than femora. 32 *fragariae*, new species. 36
35. Species with three distinct pairs of dorso-central bristles. 36
- Species with 2 distinct parts of dorso-central bristles. 39
36. Glossy black species; base of wing, squamae and small portion of pleurae pale lemon yellow; frons not one-third the width of head; anterior pair of dorso-central bristles strong; arista as long as from its base to anterior ocellus; frontal lunule yellowish, distinctly white pollinose; male with apical segments of abdomen conspicuously pale yellow. 33 *posticata* Meigen 37
- Apex of abdomen in male not yellow; frontal lunule not yellow, not noticeably white pollinose. 37
37. Smaller species, less than 2 mm. in length. 36 *dubitata*, new species. 38
- Larger species, over 2 mm. in length. 38
38. Last section of fifth vein distinctly shorter than penultimate section. 31 *neptis* Loew. 39
- Last section of fifth vein distinctly longer than penultimate section. 35 *inconspicua*, new species. 42
39. Abdomen black, without any metallic sheen; antennae brownish; arista distinctly pubescent. 37 *parricornis* Loew. 43
- Abdomen black, with a metallic, bluish, or greenish sheen; antennae black; arista never distinctly pubescent. 38 *viridula* Coquillett. 41
40. Costa to end of third vein. 41
- Costa to end of fourth vein. 43
41. Arita short, not more than three times as long as breadth of third antennal joint, distinctly pubescent; outer cross vein at its own length from inner cross vein; three pairs of dorso-central bristles on mesonotum. 39 *salicis*, new species. 42
- Arita bare; mesonotum with two pairs of dorso-centrals. 42
42. Cheeks very short, not higher posteriorly than anteriorly, and about one-sixth as high as eye; antennae of moderate size; arista about three times as long as width of third joint. 40 *winuimana*, new species. 44
- Cheeks long, distinctly higher posteriorly than anteriorly, at highest part at least one-third as high as eye; antennae rather small, arista about six times as long as width of third joint. 41 *simplex* Loew. 45

43. Male with anterior angle of cheek produced, the vibrissae formed of a number of bristles, fasciculate, turned upward and generally ending in an angle-joint; female with the mouth margin produced anteriorly, but without a fasciculus. 44
 Mouth margin not produced anteriorly in either sex; male vibrissae normal. 45
44. Large species, over 3 mm. in length; cheeks of almost equal height at anterior and posterior margins; antennae brownish; arista shortly and distinctly swollen at base; palpi almost entirely bare. 42 *vibrissata*, new species
 Smaller species, generally less than 2.5 mm. in length; antennae black; arista with elongate swelling; cheeks always higher anteriorly than posteriorly. 43
45. Small species, 1.5-2 mm.; frons weakly bristled; discal setulae not carried beyond the transverse line of the posterior pair of dorso-centrals, generally ceasing distinctly in front of that point. 46
 Larger species, 2-2.5 mm.; frons strongly bristled; discal setulae carried at least to transverse line of posterior pair of dorso-centrals generally beyond that point. 43 *affinis*, new species
46. Very small species, barely 1.5 mm.; vibrissae in male not very prominent, the anterior angle of cheeks in neither sex much produced. 44 *insularis*, new species
 Larger species, about 2 mm.; vibrissae in male prominent; anterior angle of cheek in both sexes very distinctly produced. 45 *texana*, new species
47. Species with four distinct pairs of dorso-central bristles on mesonotum, outer cross vein at barely beyond end of first vein; last section of fifth vein twice as long as penultimate section. 46 *abnormalis*, new species
 Species with generally only two distinct, rarely three, pairs of dorso-centrals, the outer cross vein at distinctly beyond end of first vein, and the last section of fifth never twice as long as penultimate section. 48
48. Eyes bare. 47
 Eyes with very distinct pubescence on the upper surface close to front of orbits. 47 *circus* Loew
49. Fore tibia with a distinct bristle on the posterior surface at about third third. 50
 Fore tibia without any distinct bristle at that point. 51
50. Thorax blue, abdomen bronzy-black; orbits with sparse pubescence and bristles situated at nearer to the eye margin than to the inner margin; squamae white, fringe concolorous. 48 *caerulea*, new species
 Thorax black; abdomen bronzy; orbits thickly pubescent, the bristles situated on nearer to the inner margin than to the eye margin; squamae grayish, margin and fringe brown. 49 *burgessi*, new species
51. Arista with very long pubescence, much longer than basal diameter of arista. 50 *plumisetula*, new species
 Arista with shorter pubescence, or entirely bare. 52
52. Mesonotum with three distinct pairs of dorso-centrals; large species, 3.5-4 mm. Larva living in galls on wistaria twigs. 51 *websteri*, new species
 Mesonotum with only two distinct pairs of dorso-centrals; smaller species, not near 4 mm., generally 2.5 to 3 mm. 53
53. Squamae grayish or brownish, margin and fringe always brown or blackish. 51
 Squamae whitish or yellowish, fringe concolorous. 47 *circus* Loew
54. Arista distinctly pubescent, and almost as long as from its base to vertex. 52 *longisetula*, new species
 Arista much shorter, less distinctly pubescent. 55
55. Large species, 2-3 mm.; outer cross vein at less than its own length from inner, inner at distinctly beyond middle of discal cell. 56
 Smaller species, distinctly less than 2 mm. 57
56. Mid tibial bristles distinct; larva in galls on lime trees. 53 *tiliae* Cresson
 Mid tibial bristles absent; larva in galls on poplar trees. 54 *schineri* Girault
57. Mouth margin with numerous, rather strong bristles, which form a group, though not a fasciculus, at anterior angle. 55 *congregata*, new species
 Mouth margin with the bristles as usual, the single vibrissa differentiated. 56 *minima*, new species

1. *Agromyza xanthophora* Schiner.

Syn: *Agromyza xanthophora* Schiner, Reise d. Novara, Vol. I, 1868, p. 261.
Agromyza picta Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 188.

Female: Head black; frons opaque, orbits slightly shining, very narrow; ocellar region raised, sub-shining, distance between ocelli less than the distance from either ocellus to eye; lower orbital bristles gradate, second pair slightly inwardly directed, the upper two pairs backwardly directed, the center pair in vertical row divergent, outer slightly convergent, post-vertical pair divergent. Frontal lunule yellow, with white pollinosity; face brown, sub-opaque, concave, wrinkled; cheeks almost linear, narrowest posteriorly, mouth margin with numerous hairs, and one strong incurved anterior vibrissa; antennae black, third joint of moderate size, rounded, arista thin, slightly thickened at base, longer than the distance from its base to post-vertical bristle, thickly covered with pubescence, which is as long as the diameter of arista at base. Proboscis pale yellow; palpi black, slightly thickened. Thorax yellow; disk of mesonotum shining, but not glossy, with a black mark covering all but the margins anterior to the suture, which is sharply indented transversely at suture, subquadrate excised centrally on the posterior margin, does not reach to scutellum, and has a dentiform longitudinal excision in each lateral lobe posteriorly; four pairs of dorso-central bristles present, the anterior two pairs reduced in size, the anterior pair just in front of suture; all black portion of disk with short hairs, yellow portion bare, except for 5-6 scattered hairs present on the central posterior excision. Pleurae with the upper half yellow, lower half black; squamae yellow at base, apically black, the hairs brown; scutellum yellow, disk bare, margin with 4 bristles; postnotum black. Abdomen yellow, third and fourth segments with indications of a central and two lateral dark spots, most distinct on fourth; fifth and sixth segments glossy black; all segments with numerous black hairs which are bristle-like on posterior margins and most noticeable on fifth. Coxae and legs entirely shining black; the tibiae with the usual two posterior bristles. Wings slightly infuscated on anterior half; subcostal vein only indistinct at apex, costa from humeral vein to end of first vein about two-thirds as long as next costal division; second, third and fourth veins slightly divergent; outer cross vein as long as penultimate section of fourth, which is distinctly shorter than the preceding section of fourth; penultimate section of fifth slightly longer than last section. Halteres pale yellow.

Length, 3 mm.

Besides the type specimen of *picta* from Frontero, Tabasco, Mexico (C. H. T. Townsend), there is in the U. S. National Museum collection one female from Las Cruces, New Mexico, June, 1893, (T. D. A. Cockerell).

Food-plant unknown.

2. *Agromyza longispinosa*, new species.

Plate XXX, Fig. 22.

Male and Female: Head yellow, ocellar region, back of head, vertex, and third joint of antennæ black; frons opaque, very pale yellow, parallel-sided, distinctly broader than the eye; bristles as in *xanthophora*. Third joint of antennæ black, sharply contrasting with the pale yellow basal joints, regularly rounded and of moderate size; arista black-brown, swelling at base of terminal section elongate, almost as long as length of third antennal joint, pubescence very short, pale; face almost perpendicular, mouth margin not produced, cheeks distinctly higher posteriorly than anteriorly, at highest part about one-third as high as greatest eye-height, the row of bristles on mouth margin not very strong, black, the vibrissa of moderate strength; proboscis and palpi yellow, the latter slightly the darker, and weakly bristled. Mesonotum yellow, with opaque black-gray mark somewhat similar in outline to that of *xanthophora* but reaching more nearly to scutellum and more elongate owing to the species being less robust than *xanthophora*; the male shows some indication of a pale, linear stripe carried forward from the central posterior excision at either anterior angle, which may in some cases be so distinct as to cause the disk to present a trivittate appearance. Four pairs of very long dorso-central bristles present, the anterior two pairs but little reduced, the anterior pair distinctly anterior to the suture, and the second pair but little posterior to it; between the dorso-centrals there are two slightly irregular rows of setulae, which are exceptionally long for this genus, and which are carried back as far as the prescutellar pair of dorso-centrals; humeri yellow, with a black spot; pleurae yellow with a brownish spot above and slightly behind fore coxae, another large one covering the space between the fore and mid coxae, and another one between the mid and hind coxae, squamae with narrow black border, and brown fringe; scutellum yellow, bare on disk, the four marginal bristles very long; postnotum glossy black. Abdomen yellow, with apical segments darkened or with bases of all segments brownish; base of ovipositor in female glossy black; hypopygium in male glossy brownish black, of moderate size; all segments with black hairs much as in *xanthophora*. Legs yellow, tarsi brownish. Wings clear, veins 2-3 divergent, 3-4 almost parallel on last fourth; second portion of costa about two and one-half times as long as first; outer cross vein a little shorter than section of fourth vein anterior to it; first and second sections of fourth vein subequal; penultimate section of fifth vein distinctly shorter than ultimate.

Halteres yellow. Length, 1.5 mm.

Type—Cat. No. 15558, U. S. N. M.

Locality: Male: Bear Lake, British Columbia, July 20, 1903, (R. P. Currie).

Paratypes: Female—Kaslo, British Columbia, July 18, 1903, (R. P. Currie); female, same locality, July 7, 1903, (A. N. Caudell), and one one male ex. collection, Wm. Bradley, without locality, but presumably Canadian.

Food-plant unknown.

2a. *Agromyza variata*, new species.

Plate XXIX, Fig. 14.

Female: Frons lemon yellow, slightly over one-third the width of head, ocellar region black; orbits darkened on outer edge on upper half; five orbital bristles present; the anterior three closely placed and decreasing much in size to front one, which is very weak; an irregular row of weak hairs on orbits, laterally, beyond the bristles; antennae of moderate size; yellow, third joint infuscated on apical half; arista brown, base swollen, pubescence very short; length of arista equal to a little more than twice the length of antenna; face and cheeks pale yellow; height of cheek posteriorly distinctly higher than anteriorly, at highest point less than one-fourth the height of eye, marginal bristles of moderate length, the vibrissa differentiated; proboscis yellow; palpi yellow, blackened and slightly dilated apically, occiput not visible on upper half. Mesonotum glossy black on disk, lateral margins and a large patch on center of posterior margin, which is rounded in front, pale lemon yellow; four pairs of dorso-centrals present, the disk except on the yellow parts covered with short black setulae; pleurae shining black, yellow along sutures and below wing base; squamae yellow, darkened on margins, fringe brown; scutellum pale yellow on disk, a black spot on each side at base. Abdomen glossy black, posterior margins of segments narrowly yellow. Legs yellow, bases of coxae, tibiae except bases, and tarsi black; no bristles on posterior surface of mid tibia. Wings clear; inner cross vein at below end of first vein and at middle of discal cell; last section of fifth vein twice as long as penultimate section.

Halteres yellow.

Length, 1.5 mm.

Type: In collection C. W. Johnson.

Locality: Calais, Maine.

Food-plant unknown.

3. *Agromyza discalis*, new species.

Plate XXX, Fig. 21.

Female: Frons yellow, opaque, almost parallel-sided, except at rear posterior margin, where the sides very abruptly diverge, in breadth it occupies less than one-third the width of head; orbits very narrow; four orbital bristles present; nearer to eye margin on orbit is an irregular row of very short hairs; ocellar region and back of head black; antennae clear yellow, of less than average size; second joint with short dorsal bristle; third joint small, not longer than broad, rounded; arista black, yellowish for a short space at just beyond the rather distinct basal swelling; pubescence indistinguishable; length of arista equal to from base to second uppermost orbital bristle, face yellow, perpendicular; cheeks yellow, twice as high at posterior margin as at anterior, and at first part rather more than one-third as high as eye; marginal bristles weak; vibrissa moderately strong; proboscis brownish yellow;

palpi pale yellow, of normal size, bare. Mesonotum shining black on disk, finely granulose; lateral margins broadly pale yellow; humeri brown; four pairs of dorso-central bristles present, the posterior pair more widely separated and stronger than the others; in addition there is in the type an additional pair of bristles, slightly anterior to the four pair, which may be abnormal; no setulae present between dorso-centrals on any part of disk; pleurae glossy black, sutures narrowly yellow; squamae pale yellow, fringe concolorous; scutellum pale yellow on disk, broadly black on sides; normal bristles four, but the type has an adventitious bristle close to base of posterior one on left side; pronotum glossy black. Abdomen glossy black; a narrow posterior marginal band on all segments, and a narrow longitudinal dorsal line on last three segments yellow; base of ovipositor glossy black; all segments with dorsal hairs, those on apex of sixth segment bristle-like. Legs yellow; blackened more or less on mid and hind coxae; bases of femora; apices of tibiae, and all tarsi; mid tibia without posterior bristles. Wings clear; first costal division one-half as long as second; subcostal vein distinct, outer cross vein at slightly before the end of first vein, and at about its own length from inner cross vein; last section of fifth vein four times as long as penultimate section; veins 2-3-4 gradually divergent on their last sections, the cells enclosed by these veins of equal width at below apex of second vein. Halteres yellow.

Length, 1.5 mm.

Type: Cat. No. 15559, U. S. N. M.

Locality: Adamana, Arizona, May 7, 1903 (H. S. Barber, one female).

This species is so evidently distinct from those of the *pusilla* group that I consider it safe to describe it from a single specimen.

Food-plant unknown.

4. *Agromyza pusilla* Meigen.

- Syn: *Agromyza pusilla* Meigen, Syst. Besch., Vol. 6, 1830, p. 185, species 60.
Agromyza pumila Meigen, l. c. p. 185, species 62.
Agromyza strigata Meigen, l. c. p. 186, species 63.
Agromyza exilis Meigen, l. c. p. 186, species 64.
Agromyza orbona Meigen, l. c. p. 186, species 65.
Agromyza pusio Meigen, l. c. p. 187, species 66.
Agromyza puella Meigen, l. c. p. 187, species 67.
Agromyza amoena Meigen, l. c. p. 187, species 68.
 (?) *Agromyza blanda* Meigen, l. c. p. 188, species 69.
 (?) *Phylomyza diminuta* Walker, Trans. Ent. Soc. Lond., n. ser. 4, 1857, p. 232.
Oscinis trifolii Burgess, Dept. Agric. Rept. 1879, p. 201.
Oscinis brassicae Riley, Dept. Agric. Rept. 1884, p. 322.

The above synonymy as I am confident correct, as an examination of a large number of specimens from widely separated localities, including Europe, and many states in the Union, reared from different food plants proves that all the

minor differences used by Meigen for the separation of his species may be found in the same species. *Agromyza blanda* Meigen may be a different species as also may *A. annulipes* Meigen, species 61 of the series quoted in synonymy, but they may only be color varieties. The number of examples in existence representing Meigen's types of this group are as follows: *pusilla*, 1, (Paris); *annulipes*, 1, (Paris); *pumila*, 1, (Vienna); *exilis*, 1, (Paris); *pusio*, 1, (Paris); 2, (Vienna); *cebona*, 1, (Vienna); *puella*, 1 defective specimen, (Vienna); *puona*, 1, (Paris); *blanda*, 1, (Paris).

Male and Female: Black, shining. Marked in most variable degree with yellow. Frons except ocellar region, and sometimes a narrow side stripe posteriorly, yellow; remainder of head parts except hind vertex, yellow. Mesonotum with a more or less broad yellow margin, which never extends distinctly round the anterior nor posterior margin; four pairs of dorso-central bristles present as well as numerous long hairs on disk; humeri with a black spot. Pleurae with sometimes as much as in *xanthophora* and at other times almost entirely black, with the sutures and upper margin yellow; scutellum entirely yellow, or yellow with black basal side spots, which in some cases extend almost round the entire margin and on to the disk; postnotum black. Abdomen yellowish with dark brownish bases to segments, black with black apices to segments, or entirely shining black with the apical segments whitish, or yellowish, at apex. Legs almost entirely yellow, the hind only brownish, to legs almost entirely black with knee joints yellow. Tibia more generally less intensely black than other parts of legs. Mid tibiae without distinct posterior bristles. Wings clear; second division of costa about two and one-half times as long as first section, third and fourth veins divergent at extremities; outer cross vein as long as or slightly shorter than the section of fourth anterior to it, basal two sections of fourth subequal or the second slightly the shorter; last section of fifth vein about three times as long as preceding section.

Halteres yellow.

Length, 1-1.75 mm.

This is a most variable species in color and is very widely distributed. The following is a list of states from which it is represented in the material I have examined. (A full list of American localities, with list of food-plants will appear in the economic bulletin, now ready for the press, dealing with this species).

Massachusetts, Connecticut, District of Columbia, Arizona, Wyoming, Texas, Colorado, California, Utah, Kansas, New Mexico, Indiana, Idaho, Florida and Virginia. It is probable that this species occurs all over the United States.

5. *Agromyza scutellata* Fallen.Syn: *Agromyza scutellata* Fallen Dipt. Succ. *Agromyza*. 1823. 7. 3.*Agromyza flaveola* var. Fallen, l. c. 6, 11.*Agromyza pictella* Thomson, Fregat. Eugene. Resa, Dipt. 1851, 51, p. 44.

I have compared examples of the European species with those in collection representing *pictella* and am convinced they are identical. I have some slight doubts as to its specific distinctness, from the foregoing species, but consider it justifiable to retain it as separate species until I know something of the life history of *scutellata*, which has not been bred in this country.

Male and female: Similar in coloration to *pusilla* Meigen, except that the femora are generally the most intensely black portions of the legs and in no examples that I have seen is there any appearance of their being inclined to yellow, especially at base. In size this species is also larger and the wing venation is different. Otherwise, in bristling, etc., the species are identical.

The only American examples I have seen of *scutellata* are five from mountains near Claremont, California (C. F. Baker) and one from Williams, Arizona (H. S. Barber).

6. *Agromyza borealis* new species.

Plate XXIX, Fig. 10, Plate XXX, Fig. 23.

Female: This species is very close to *longispinosa*, but differs in being more robust, in having the frons reddish yellow, instead of pale yellow; the antennæ are reddish yellow; the arista is black, tapering from base to near middle, bare, and distinctly shorter than from its base to vertex; cheeks more than one-half the eye-height; marginal mouth bristles numerous, vibrissæ hardly differentiated. Mesonotum with the marks dull gray black; the posterior lateral stripes narrow, linear, distinctly separated from the inner lateral lobe; the central expanse carried forward at its angles but not sufficiently to separate the inner lateral stripes from the central one on their whole length; four pairs of dorso-central bristles present, the anterior two pairs about two-thirds as large as the posterior pairs; the thorax is distinctly broader than in *longispinosa*, being almost subquadrate, in *longispinosa* it is at least one-third longer than broad; the small bristles between the dorso-centrals are at least four-rowed in *borealis*. The pleuræ and scutellum are bristled and colored as in *longispinosa*, the scutellum having two distinct dark lateral basal spots. Abdomen yellow, basal three segments brownish, next two with a brownish spot on each side, sixth with a central black spot; base of ovipositor glossy black, longer than sixth segment, which is not elongated, bristles as in *melampyga*. Legs yellow, tarsi slightly browned; mid tibiæ as in *longispinosa*, without the posterior bristles. Wings grayish, veins yellowish, except third which

is brown; outer cross vein more than its own length from inner cross vein; first and second sections of fourth vein equal; first portion of fifth equal in length as long as last portion. Halteres yellow. Length, 1.5 mm.

Type: Cat. No. 15560, U. S. N. M.

Much as I dislike the idea of describing a new species from a single specimen, I believe that in this case I am justified in doing so, as the specimen is in good condition and presents some good characters for its separation from *longispinosa* and its allies. (Compare *arcticum* Lundbeck)

7. *Agromyza flavonigra* Coquillett.

Plate XXX, Fig. 27.

Agromyza flavonigra Coquillett, Jour. N. Y. Ent. Soc., Vol. 10, 1902, p. 189.

Female: Head yellow, ocellar region and back of head brownish or blackish; frons distinctly, but not greatly, wider than one-third the head width; almost parallel-sided; the orbital bristles strong, black; antennae rather small, yellow, third joint rounded in front, arista brown, yellow at base, almost bare, and falling just short of reaching to vertex; base distinctly swollen, elongate; cheeks broad, one-third higher posteriorly than anteriorly, and at former place one-half as high as eye-height; marginal bristles of moderate length, vibrissa not strong but distinctly longer than the other marginal bristles; proboscis and palpi yellow; palpi linear, with numerous short, black bristles. Mesonotum marked much as in *melampyga*, but the posterior quadrate excision in center has two linear, yellow, anterior prolongations which divide the black portion more or less distinctly into three vittae; the posterior, longitudinal, yellow, dentiform incision of the outer lobe is also prolonged, and separates the outer portion of the posterior half of the black mark, so that it forms a separate black stripe giving the dorsum the appearance of having five vittae. Four pairs of dorso-central bristles present, the anterior two pairs somewhat reduced in size. In other respects the thorax is much as in *melampyga*, but the fringe of the tegmen is pale and there is a lateral black spot at base on each side of sternum. Abdomen yellow; first to fourth segments with a dorsal, brown, central spot, fifth with a pair of close placed spots on center of disk, sixth with a pair at near base which are wider placed than those on fourth, and another larger pair more widely placed at about middle; sixth segment about four times as long as fifth; base of ovipositor dusky black, conical, as long as sixth segment; all segments with numerous black hairs, those on apices of last two segments bristle-like. Legs yellow, brown on base of fore coxae, bases and apices of all femora, as well as the entire tibiae and tarsi of all legs. Wings much as in *melampyga*, but the inner cross vein is rather before the end of first vein, the second portion of fourth vein is shorter than first, the outer cross vein rather oblique, and the first section of fifth is shorter than in *melampyga*, being only two-thirds as long as last section. Length, 3 mm.

Locality—Beulah, New Mexico, (T. D. Cockerell). Redescribed from type specimens. Food-plant unknown.

8. *Agromyza melampyga* Loew.

Plate XXX, Fig. 20; Plate XXXI, Fig. 31.

Syn: *Agromyza melampyga* Loew, Dipt. Amer. Sept. Indig. Cent. 8, 1898.*Agromyza sorosis* Williston, Trans. Ent. Soc. London, 1896, p. 429.*Agromyza flaviventris* Johnson, Can. Ent. Vol. 34, 1902, p. 242.

Male and Female: Head yellow, only black behind and on occipital region; frons about one-third the width of head, almost parallel-sided except at just anterior to vertex, where the eyes round off and the frons becomes rather abruptly wider; bristling normal; cheeks margin distinctly higher posteriorly, marginal bristles weak, anterior vibrissae incurved, of moderate size; antennae rather below the average of third joint rounded, arista brown, tapering, distinctly but shortly pubescent, slightly longer than the length of frons from its base to vertex; proboscis and palpi yellow. Thorax colored and marked as in *camptophora*; four pairs of dorso-central bristles present; the anterior two pairs much reduced in size; other bristling as in that species; squamae brownish from near base, the apex blackish, fringe brown. Abdomen varying from yellow to brown, with pale apices to segments; all segments with numerous black hairs. Legs generally entirely yellow, sometimes the tibiae and tarsi are darkened somewhat; mid tibiae with two yellow posterior bristles present. Wings clear, or slightly grayish; first costal division about one-half as long as second; second, third and fourth veins divergent on outer third; outer cross vein distinctly shorter than section of fourth vein anterior to it, or almost as long as it, first and second sections of fourth vein subequal, or the former slightly the shorter; penultimate section of fifth vein about three-fourths as long as ultimate section. Halteres yellow.

Length, $1\frac{1}{2}$ -2 mm.

This species was originally described from District of Columbia, (Osten Sacken) by Loew. Coquillett records it (Bull. 10 in ser. U. S. Dept. Agric. 1898, p. 77) as bred from leaves of a cultivated species of *Philadelphicus*, collected at Washington, D. C. during the latter part of July, 1884, and from mines in leaves of *Plantago major*, collected June 28, 1888, same locality. He states that the larva pupated within the mines. These specimens are in collections at U. S. National Museum. Besides these specimens there is one from Biscayne Bay, Florida, (Mrs. A. T. Slosson) and I have examined a series reared from Plantain, June 26, 1912, Lafayette, Indiana (J. J. Davis).

Johnson described *flaviventris* from Niagara Falls, New York. Williston's species was from St. Vincent, West Indies. Other localities: New Jersey (Smith); White Mountains, New Hampshire (Mrs. A. T. Slosson).

Agromyza melampyga var. **marginalis**, new variety.

Male and Female: This variety differs from the type in being rather smaller 11½ mm.; in being comparatively more strongly bristled, in having only the margins of the thoracic markings black, the remainder being yellowish, and in having the arista shorter, barely reaching the vertex in the only specimen in which it is extant.

The three specimens, two males, one female, were reared from *Paspalum*, (Oct. 2, 1912). Locality: Columbia, South Carolina, (P. Luginbill) Webster, No. 9711.

Type: Cat. No. 15561, U. S. N. M.

It is possible that this is a distinct species, but the material is too scanty to give one a basis for a definite opinion as to whether it is so, or whether the effect of a different food plant is responsible for the variation in color, etc.

9. Agromyza brevicostalis, new species.

Plate XXVIII, Fig. 8.

Female: Frons lemon yellow; one half as broad as head and distinctly broader than long; center stripe blackened on anterior half; orbits differentiated from center stripe; four orbital bristles present; in addition to the bristles there is a row of weak hairs nearer to eye margin, which begins at opposite base of antennae and continues to beyond upper orbital bristle; ocellar region raised, brown; back of head and a triangular patch at lateral angle of orbits brown, or black-brown; lunule yellow; antennae of moderate size, black brown; second joint with distinct dorsal bristle; third joint rounded in front, covered with short pilosity; arista brown; basal swelling elongate; pubescence very indistinct; length of arista equal to from its base to upper orbital bristle; face yellow, blackened on depressions below antennae; concave in profile; keel slight; cheeks yellow, blackened anteriorly, distinctly darker posteriorly than anteriorly; height at highest part less than one-half the height of eye; occiput not projecting on upper half; proboscis yellow; palpi black, normal. Mesonotum gray black, subopaque, locally pale yellow on lateral margins; a small patch on each side anteriorly, the pale color extending slightly on to anterior lateral angle of scutellum; four pairs of dorso-centrals present, the anterior two pairs reduced in size; no distinct dorso-centrals anterior to suture, though the 3 setulae immediately anterior to suture in line with dorso-centrals are rather strong; discal setulae upright, not very numerous; setae in irregular rows between the dorso-centrals; the pair of bristles between the posterior pair of dorso-centrals distinct, and of moderate length; humeri yellow, with a dark discal mark; pleurae black-gray, not shining; sutures and upper margin narrowly, and a patch below on base yellow; squamae yellow, fringe brown. Abdomen glossy black; posterior margins of all segments narrowly pale yellow; segments with numerous hairs, stronger on posterior margins; base of ovipositor black, as long as preceding segment. Legs black, glossy, knees

with a double row of bristles, the upper of which are directed forward and slightly upward, and continue to lowest level of eye anteriorly, vibrissa stronger than other bristles, incurved, situated lower than anterior bristles on ridge above; antennae rather small, second joint with short bristles in addition to the dorsal one, and none on under side, third joint rounded except on dorsal surface at apex where it is truncate; arista but little swollen at base, thickly but sparsely pubescent, and shorter than from its base to anterior ocellus; palpi brownish; palpi black, of moderate size, normal in shape, rather distinctly bristled. Mesonotum with three pairs of dorso-central bristles, and one or two long hairs anterior to the third pair; in addition to these the disk is covered with numerous short hairs. (The large male used for transfixing the two specimens have practically destroyed the thorax and make it very nearly impossible to judge the nature of the chaetotaxy, and it may be that in some cases the species has four instead of three pairs of dorso-centrals). Scutellum four bristled, disk large, squamulae whitish, fringe pale. Abdomen glossy black, all segments with numerous hairs, those on apex of sixth segment bristle-like, base of ovipositor glossy black, longer than fifth segment. Legs entirely black, the mid tibiae with the pair of posterior bristles present. Wings grayish, veins brown, costa carried indistinctly beyond third vein, but falling much short of fourth; inner cross vein at end of first vein, outer cross vein at slightly beyond center of wing, and at nearly twice its own length from inner cross vein; second section of fourth vein shorter than first, and rather more than one-fourth as long as last section; last section of fifth three-fifths as long as the preceding section.

Halteres white.

Length, 3 mm.

Type: Cat. No. 15565, U. S. N. M.

Locality: Juneau, Alaska, July 25, 1899, (Kincaid).

The paratype which is in rather poor condition differs slightly from the type in neuration, having the outer sections of the veins comparatively longer than in the type.


The species is named in honor of Prof. Trevor Kincaid, who collected it.

This is the species recorded by Coquillett as *A. neptis* Loew. (Proc. Wash. Acad. Sci. Vol. 2, 1900, p. 463), occurring in Alaska. It is very close to the species described by Schiner (Fauna Austriaca, Vol. 2, 1864, p. 303) as *nigripes* Meigen. He misidentified Meigen's species which has the costa to the fourth vein. Afterwards Rondani placed Schiner's species in *Domomyza* and retained the specific name as *nigripes* Schiner (nec Meigen). This generic division has been repudiated by various writers, and as no other valid name has been given to this species it must be renamed. (See Addenda.)

13. *Agromyza parvicella* Coquillett.

Plate XXVIII, Fig. 4; Plate XXX, Fig. 17.

Syn. *Agromyza parvicella* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 189.

Female:  Black, slightly shining; very slender species. Frons brown, yellowish in front, almost black at vertex, occupying more than one-half the width of the head; orbits distinct, darker than frontal space, each orbit rather more than one-half as wide as frontal stripe. Bristles, four on each side from anterior ocellus, situated near outer margin of orbit; the upper two stronger than the lower two, posterior bristles divergent; frons in profile slightly projecting, face slightly concave, mouth margin not projecting, face subshining, black; clypeus yellowish, more than one-half as high as eye, and of almost equal breadth on their entire length, marginal bristles weak, vibrissae long, but not strong; antennae black, second joint with the usual dorsal bristle, which is hair-like, otherwise entirely bare, third joint subquadrate, of moderate length, falling short of mouth margin, gently rounded at apex, arista thickened at base, very short, barely one and one-third times as long as antennae, thickly, but very shortly pubescent; proboscis yellow at apex, membranous; palpi black, slightly projecting beyond upper mouth margin; occiput swollen from slightly below upper margin of vertex. Mesonotum subshining, four pairs of dorso-central bristles present, the pair anterior to the suture, and the anterior pair behind suture slightly smaller than the posterior pairs; two irregular rows of bristles between the dorso-centrals; pleurae concolorous with disk of mesonotum, but glossy on lower portion; scutellum with four marginal bristles, disk bare; squamæ brownish, fringe long, brown. Abdomen concolorous with thorax; first segment elongated, about twice as long as second, remaining segments subequal; last abdominal segment glossy black; all segments with scattered, rather long hairs, those on apex of each segment longest. Legs long and slender, brown, trochanters, apices of femora and bases of tibia narrowly yellowish; no bristles present on mid tibiae. Wings brownish, costa reaching only to end of third vein, second costal division two and one-half times as long as first, subcostal vein indistinct, obsolete on apical fifth; outer cross vein slightly before end of first vein, and at about its own length from inner cross vein, second section of fourth vein one-half as long as first; section of fifth vein between cross veins about one-fifth as long as last section; fourth vein indistinct, anal cell distinct, anal vein strong, reaching nearly to wing margin. Halteres yellow.

Length, 2 mm.

Locality: St. Paul Island, Alaska, (Kincaid).

Food-plant unknown.

Redescribed from type specimen in U. S. National Museum Collection. This species is rather different from most species in *Agromyza* and may be considered by some writers as belonging to some of the other families in the Acalypterate Muscidae, but I believe it may be most clearly associated with this genus. Like the next species it belongs to the segregate

of *Agromyza* with the costa to third vein only. This character is not of such importance that it may be considered as of generic value, and I therefore am not using Rondani's generic name *Domomyza*, as species which are very dissimilar are thrown together in *Domomyza*, and thus separated from forms to which they are more closely allied in *Agromyza*.

14. *Agromyza nitida*, new species.

Plate XXVIII, Fig. 1; Plate XXX, Fig. 26.

Female: Frons reddish yellow, distinctly longer than broad, ocellar region black; vertex and orbits posteriorly blackened; upper parts of frons shining, lower and central parts opaque; five pairs of moderately strong orbital bristles present, which are of almost uniform size and situated nearer to inner margin of orbits than to eyes; flag slightly keeled, brown, in profile a little concave; antennae brownish yellow, very short, second joint almost bare, the dorsal bristle weak, third joint longer than broad, twice as long as second, regularly rounded at apex; arista brown, slightly thickened at base, almost bare, not as long as half the length of from its base to vertex; cheeks yellow, lower margin narrowly shining black, in outline lower margin rounded, height posteriorly rather less than one-third that of the vertically elongate eye, anteriorly not so high; marginal bristles very weak, vibrissa present but not strong; proboscis yellowish brown; palpi concolorous, small, not dilated, bare. Thorax rounded above; mesonotum about one-third longer than broad, glossy black, covered on the disk with short setular hairs, two pairs of rather widely placed, post-sutural, dorso-cubital bristles present, the pair of strong hairs between the posterior pair absent; humeri pale yellow, margins of mesonotum brownish; pleurae brownish-black, glossy, upper margin narrowly yellow along suture in front of wing base also yellowish; squamae yellowish, the marginal fringe brown; scutellum rounded, concolorous with mesonotum, four marginal bristles present. Abdomen glossy black-brown, segments with an indication of a linear, yellow, posterior margin; ovipositor glossy black, barely longer than preceding segment; all abdominal segments with scattered hairs, those on the apical segment not much longer than the others. Wings grayish; auxiliary vein completely indistinct; second costal division about two and one-third times as long as first; cutter cross vein situated directly below end of first vein and at its own length from inner cross vein, portion of fourth vein anterior to inner cross vein slightly more than twice as long as section beyond it; third and fourth veins regularly divergent on the whole of the last section, latter much less distinct than the longitudinal veins anterior to it; penultimate section of fifth vein one-third as long as ultimate section; costa reaching slightly beyond end of third vein. Halteres with yellow stalk and white knob.

Length, 1.5 mm.

Type: Cat. No. 15566, U. S. N. M.

Locality: Cabin John Bridge, Maryland, April 28, 1912.
(Knab and Malloch). Food-plant unknown.

15. *Agromyza immaculata* Coquillett.

Plate XXVIII, Fig. 3.

Syn: *Odinia immaculata* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 185.

Female: Frons yellow, or reddish yellow, almost parallel-sided, in breadth distinctly, but not greatly, more than one-third the head width; ocellar region black; orbits whitish; entire frons opaque; orbital bristles strong, only three pairs anterior to lower ocellus; the lower pair of which are incurved; face and cheeks pale yellow, the former almost perpendicular and with indistinct keel, the latter distinctly higher posteriorly than anteriorly, at middle less than one-third as high as eye height; marginal mouth bristles distinct, vibrissa not much longer than other bristles; antennae yellow, brownish on upper and outer surfaces, dorsal bristle on second joint distinct, but no other noticeable bristles present; third joint of moderate size, more than twice as long as second, regularly rounded at apex, distinctly longer than broad; arista brown, with almost the basal third swollen, lanceolate, bare, in length as long as from its base to vertex; proboscis and palpi yellow, the latter with 2-3 weak hairs at apex. Mesonotum opaque gray, the space between the dorso-central bristles opaque, yellowish, with the appearance of pollinosity; four pairs of strong dorso-centrals present, which are in parallel rows, and but little weaker anteriorly, two rows of bristles between dorso-centrals, which are regular, equally spaced from dorso-centrals and from each other, and are not continued beyond middle of disk; besides the other normal bristles there are only 3-4 small setulae laterally beyond the dorso-centrals; humeri yellow, with a black spot, lateral margins of mesonotum yellow; pleurae yellow, a longitudinal, elongate spot on middle from propleura over mesopleura, a large triangular spot between fore and mid coxae, a spot above hind coxae, and a less distinct one below wing base; squamae brownish, fringe brown; scutellum concolorous with disk of mesonotum, the yellow central stripe more distinct and, narrowly, much paler, with more the appearance of ground than surface color, in shape the scutellum is subtriangular, flattened on surface; four marginal bristles present; post-scutum anteriorly yellow, posteriorly shining black. Abdomen brownish with the posterior margins of basal four segments narrowly, and apex of sixth broadly yellow, or the sixth entirely yellow and the others broadly yellow at apices; ovipositor glossy brown, shorter than sixth segment; all segments with numerous hair-like bristles. Legs yellow, marked with brown on base of fore coxae, upper surface and base of all femora; tibiae and tarsi more or less brownish tinged; mid tibiae without the posterior bristles. Wings grayish on anterior half; subcostal vein indistinct; first costal division one-third as long as second; outer cross vein distinctly beyond end of first vein, and at about twice its own length from inner cross vein, first division of fourth vein shorter than second, first section of fifth vein about three-fourths as long as last section; third and fourth veins subparallel, only distinctly divergent at extreme apices. Halteres pale yellow.

Length, 2 mm.

Type: Cat. No. 6649, U. S. N. M.

Type Locality: Mt. Washington, New Hampshire, May 1, 1892, A. T. Slosson).

Besides the type there are specimens in collection from the following locations: Two specimens, Santa Fe, New Mexico, (May), (H. S. Barber), one specimen St. Louis, Missouri, April 30, 1904 (W. V. Warner); and one specimen, Ketchikan, British Columbia, July 17, 1903, (R. P. Currie).

Food-plant unknown.

The type specimen has the yellow thoracic markings on disk and scutellum rather indistinct, but in other respects is similar. It is a true *Agromyza* and has very little in common with *Odinia ornata* Zetterstedt, which is represented in the U. S. N. M. collection by one specimen from Dauphin county, Pennsylvania.

16. *Agromyza citreifrons*, new species.

Male and Female: Frons opaque, lemon yellow, distinctly longer than broad, one-half as wide as head, parallel-sided; orbits more or less blackened or browned, especially posteriorly; three pairs of long, thin, orbital bristles anterior to front ocellus, the upper distinctly in front of anterior ocellus, anterior to lower bristle there is a weak hair, otherwise the orbits are bare; ocellar region and back of head black; antennae of moderate size, clear lemon yellow; second joint bare except for the weak dorsal bristle; third joint rounded, about three times as long as second; arista concolorous with antennae on the swollen base, brown on remainder, almost bare, barely as long as from its base to anterior ocellus; face yellow, slightly retreating in profile; cheeks concolorous, higher posteriorly than anteriorly, at highest part over one-third the height of eye; eye slightly longer than high; marginal mouth bristles not numerous (4-5) but rather strong, the vibrissa hardly differentiated; proboscis and palpi clear lemon yellow. Mesonotum opaque, brown-black; lateral margins and humeri brownish yellow; four pairs of dorso-central bristles, arranged in parallel rows, anteriorly reduced in length; setulae between dorso-centrals irregularly arranged in 3-4 rows, extending to posterior margin; pleurae lemon yellow, a large brown or blackish triangular spot between the fore and mid coxae, another smaller one over hind coxae and an indistinct longitudinal mark sometimes present on mesopleurae on middle; squamae brownish, fringe brown; scutellum brown, with four marginal bristles; postnotum black. Abdomen shining brown, or blackish, lateral margins yellow in female, over color of female glossy brown-black, as long as preceding segment of abdomen; hypopygium of male brownish, organs knob-like, of moderate size; anal segments with numerous black hairs, which are noticeably longer on lateral margins and apices of last two segments. Legs yellow, hind browned; mid tibia without posterior bristles. Wings clear or slightly

first costal division half as long as second, veins 2-3-4 together slightly divergent on last sections, outer cross vein at beyond end of first vein, and at a little more than its own length from inner cross vein or beyond own length from it, second section of fourth vein distinctly shorter than first; last section of fifth vein about twice as long as penultimate.

Halteres lemon yellow.

Length, 1-1.5 mm.

Type: Cat. No. 15567, U. S. N. M.

Type locality: Eureka, California, (H. S. Barber). Seven specimens. I have seen one specimen in C. W. Johnson's collection from Princeton, Maine, July 12, 1908.

Food-plant unknown.

17. *Agromyza pruinosa* Coquillett.

Syn: *Agromyza pruinosa* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 189.

Male: Frons opaque, center stripe reddish, merging into brown on margins and posteriorly, orbits not distinctly differentiated, and, with outer margin of center stripe, blackish; breadth of frons one-half as wide as head; five orbital bristles present, the lower four pairs incurved, the upper one backwardly directed, no distinct orbital hairs present; vertical row and postvertical pair strong; lunule not differentiated from center stripe; face and cheeks reddish yellow, the former concave in profile, keel distinct, and brownish; eye orbits carried back over cheeks, blackish, cheeks and orbits at posterior angle of eye as high as eye; marginal bristles on mouth opening 4-5 in number, strong, upwardly directed, vibrissa hardly stronger, though distinct; proboscis and palpi reddish yellow. Mesonotum grayish black, opaque, elongate, about one-half longer than broad; four pairs of dorso-centrals present, about three irregular rows of setulae between the dorso-centrals; the pair of bristles between posterior pair of dorso-centrals distinct; pleurae subshining, black-brown, paler below wing base; squamae of moderate size, whitish, fringe brown. Abdomen subshining, brownish; hypopygium yellowish brown; of moderate size, all segments strongly haired. Legs strong; reddish yellow, bases of femora, apices of tibiae broadly, and entire tarsi brown; fore femora with distinct, rather long central bristles; mid tibia without any distinct posterior bristles. Wings slightly grayish; first costal division at least one-half as long as second, subcostal vein rather indistinct, complete; inner cross vein at very slightly before end of first vein, outer cross vein slightly outward bent at middle, at almost its own length from inner, and at very little beyond wing middle; veins 2-3-4 distinctly divergent on the outer section; second and third sections of fourth vein together half as long as last section; last two sections of fifth vein subequal. Halteres whitish yellow.

Length, 2.5 mm.

Redescribed from type (Cat. No. 6659, U. S. N. M.).

Locality: Colorado, (H. K. Morrison).

Food-plant unknown.

18. *Agromyza indecisa*, new species.

Female: Frons elongate, fully one and one-third times as long as broad, two-fifths as wide as head; orbits barely darker than central stripe; four equally strong orbital bristles anterior to front ocellus, the upper only slightly lower than anterior ocellus; besides these strong bristles there are several weak hairs situated nearer to eye margin opposite spaces between the bristles; antennae reddish yellow, shaped and bristled as in *citrefrons*, arista entirely brown-black, distinctly swollen at base, almost bare, not reaching to anterior ocellus; face pale yellow, not produced at mouth margin, slightly keeled; cheeks distinctly higher posteriorly than anteriorly, at highest part one-third as high as eye; bristles much as in *citrefrons*; eye as high as long; palpi and labris yellow. Mesonotum black, subshining, disk slightly gray pollinose; lateral margins and humeri pale yellow; four pairs of dorso-central bristles present; anterior to the one in front of suture there is a small bristle which may be abnormal; other bristling as in *citrefrons*; pleurae brown-black, shining; sutures yellow, square brown; scutellum concolorous with disk of mesonotum, four bristles; postnotum shining black. Abdomen subopaque, brown-black; segments narrowly bordered posteriorly with yellow; ovipositor with base as long as sixth segment; bristles as in *citrefrons*. Legs yellowish brown; fore coxae, with ventral surfaces and apices of femora yellow; posterior mid tibial bristles absent. Wings grayish; second costal division short of twice as long as first; subcostal vein rather distinct; outer cross vein beyond end of first vein, and at about its own length from inner cross vein; first section of fourth vein longer than second; last section of fifth twice as long as penultimate section. Halteres yellow.

Length, 1.5 mm.

Type: Cat. No. 15568, U. S. N. M.

Locality: Las Vegas, New Mexico, June, 1901, 11,000 feet level, (T. D. A. Cockerell).

Food-plant unknown.

19. *Agromyza varifrons* Coquillett.

Syn: *Agromyza varifrons* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 189.

Female: Frons parallel-sided, subopaque, center stripe and orbits clear reddish yellow on lower half, blackened on upper half; orbits differentiated from center stripe, very narrow, each about one-fifth as wide as center stripe; four orbital bristles present, which are slightly reduced in strength from upper to lower bristle; no hairs on orbits besides the bristles; antennae yellow, darkened on third joint at insertion of arista; second joint with dorsal bristle and weak apical hairs; third joint rounded in front, of moderate size, not longer than broad, covered with thick, but very short, white pilosity; arista brown, short, about one and one-third times as long as antenna, and as long as from its base to between upper two orbital bristles; pubescence very short but close; face and cheeks yellow, paler than frons, the latter gradually becoming higher towards

posterior margin, at posterior margin less than one-third the eye height, bristles on margin rather weak, vibrissa well differentiated; proboscis and palpi yellow. Mesonotum glossy black, humeri brownish; two pairs of dorso-central bristles present; disk with numerous short setulae; pleurae glossy black, brownish below wing base, squamae grayish, margin and fringe brown; scutellum and postnotum concolorous with disk of mesonotum. Abdomen glossy black; base of ovipositor distinctly longer than preceding abdominal segment; posterior marginal bristles on last abdominal segment strong. Legs brown, apices of femora and bases of tibiae paler, yellowish, mid tibia without distinctly differentiated posterior bristles. Wings clear, broad; first costal division almost one-half as long as second; inner cross vein beyond end of first vein, outer cross vein at below middle of wing, taking its upper end as below middle of costa, and at less than its own length from inner cross vein; second section of fourth vein less than one-half as long as first, first and second sections of this vein together half as long as last section; veins 2-3-4 divergent, fourth vein at below apex of wing; last two sections of fifth vein subequal. Halteres pale yellow. Length, 2 mm.

Redescribed from type. (Cat. No. 6658, U. S. N. M.).

Locality: Washington, District of Columbia, (collection Coquillett). A male in C. W. Johnson's collection from Pottstown, Pennsylvania, differs from the type in having the frons and antennae paler lemon yellow, the arista slightly longer, and the cheeks distinctly over one-third the height of eye. In other respects similar to the female.

Food-plant unknown.

20. *Agromyza platyptera* Thomson.

Agromyza platyptera Thomson, Eugene Rosa, 1851-1853, p. 608.

Agromyza crenata Loew, Dipt. Amer. Sept. Indig. Cent. S. 1859, p. 162.

Agromyza jucunda v. d. Wulp., Tijdschr. v. Entom. Vol. X, 1866, p. 161.

Oscinis malvæ Burgess, Dept. Agric. Rept. 1879, p. 202.

Agromyza lateralis Williston, Trans. Ent. Soc. Lond. 1896, p. 428.

Male and Female: Frons opaque, lemon yellow; orbits sometimes posteriorly blackened, four pairs of orbital bristles anterior to front ocellus; frons generally over one and one-half times as long as broad, and one-third of the head with; ocellar region and back of head black; face slightly concave in profile, yellow, slightly keeled in center; cheeks yellow, rather short, higher posteriorly than anteriorly, at highest part short of one-third the height of eye; eye higher than long; bristles on fourth margin moderately strong, numerous, upper ones upturned, vibrissa stronger than other bristles; proboscis yellow; palpi black, normal in shape; antennae black; dorsal bristle on second joint weak, third joint short, regularly rounded, higher than long, arista brown-black, swollen at base, very shortly pubescent; not as long as from its base to vertex. Mesonotum shining black; lateral margins, including humeri, broadly pale yellow; two pairs of dorso-centrals present, some-

than first and twice as long as outer cross vein; third and fourth veins almost parallel from outer cross vein, only divergent at extreme apical section of fifth vein about one-fourth longer than penultimate section. Halteres yellow.

Length, 2 mm.

Type: Female. Cat. No. 15569, U. S. N. M.

Type locality: Fort Collins, Colorado, Webster's No. 6610, (C. N. Ainslie), bred from oats

Paratypes: Tower City, North Dakota, Webster's No. 3047, (G. I. Reeves), swept amongst grass; Fort Collins, Colorado, Webster's No. 6646, reared from *Hordeum jubatum*; July, 1910, (C. N. Ainslie); Buckton, Kansas, Webster's No. 5555; reared from volunteer wheat, June 11, 1909, (C. N. Ainslie); Hawkins, Summit County, Ohio (?), August 16, 1902 (no collector's name); Massachusetts (collection Coquillett). I have also examined specimens from C. W. Johnson's collection from the following localities: Fern Rock, Pennsylvania; Norwich, Vermont, Nantucket, Massachusetts and Hanover, New Hampshire.

This species is named in honor of the late D. W. Coquillett, whose work has done much to facilitate an understanding of the North American Diptera.

22. *Agromyza longipennis* Loew.

Syn: *Agromyza longipennis* Loew, Dipt. Amer. Sept. Indig., Cat. N. Am. species 90.

Female: Frons pale lemon yellow, incision above lunule slightly darkened; orbits blackened posteriorly; ocellar region black; breadth of frons equal to over one-third the width of head, in outline the sides of frons almost parallel or a little divergent anteriorly; four pairs of long orbital bristles present, in addition to the bristles there is an irregular row of weak hairs nearer to eye margins, which begins at base of antennae and extends to opposite the anterior ocellus; antennae brownish yellow, darker dorsally, of moderate size; second joint with weak hairs at apical margin, and the usual dorsal bristle of moderate length; third joint rounded, covered with thick, but short, pilosity; arista brownish, swollen at base, very thickly pubescent, the pubescence as long as basal diameter of arista, arista as long as from its base to posterior ocelli; face and cheeks clear lemon yellow, the former slightly concave and with slight keel; cheeks about twice as high at posterior as at anterior margin, at highest part slightly less than one-third the eye height; eye distinctly higher than long, marginal mouth bristles weak but numerous, vibrissa strong. Mesonotum subshining, black, four pairs of almost equally strong dorso-central bristles present; between which are 4-5 rather irregular rows of setulae, no distinctly differentiated bristles between posterior dorso-centrals; lateral margins of mesonotum

Scutellum brownish, pleurae brown-black, subshining; upper margin of wing narrowly yellow; costal vertical suture, and below base of wing narrowly yellow; venation concolorous with mesonotum, four bristled; postnotum brown, shining. Abdomen shining brownish or blackish; ovipositor black, base slightly longer than last abdominal segment, covered with numerous short hairs. Legs brownish; fore coxae, bases of all femora broadly, and bases of tibiae yellow; the basal two pairs of femora generally almost black; posterior bristles absent from mid tibiae. Wings elongate, clear or slightly grayish; first costal division one-third as long as second; inner cross vein at just below end of first vein or very slightly beyond it; outer cross vein distinctly shorter than section of fourth vein anterior to it, first and second sections of fourth vein subequal, last two sections of fifth vein subequal. Halteres pale yellow. Length, 2.5 to 3 mm.

Originally described from District of Columbia (Osten Sacken).

Represented in collection by two specimens from Mount Washington and Franconia, New Hampshire, (Mrs. A. T. Slosson, collection Coquillett); and two from Algonquin, Ill., (collection Coquillett). Three of the specimens were standing as *A. xanthocephala* Zetterstedt, in collection. This identification may have been given out by Coquillett, though I cannot find any published record of the name. Zetterstedt's species differs from Loew's in having the legs entirely black. *Longipennis* comes very close *capitata* Zetterstedt as understood in Britain, but I have no specimens for comparison, and as Kertész gives *capitata* as a synonym of *geniculata*, which I have from Holland, and find distinct, I consider it advisable to continue the use of Loew's name, meantime.

Food-plant unknown.

23. *Agromyza coloradensis*, new species.

Male and Female: Frons opaque, ochreous yellow, about one-third wider than broad, sides almost parallel; orbits at lunule not one-half as wide as center stripe at same part; five pairs of orbital bristles present, the nearest antennae weakest; these bristles occupy middle of orbit laterally beyond them is an irregular row of short hairs which extends from base of antennae to fifth orbital bristle; sides of orbits and vertex of head blackened; ocellar region shining black; antennae black; first joint and apex of second on inner surface yellow; second joint with numerous short hairs on dorsal and ventral surfaces, the dorsal bristle longest; third joint of moderate size, slightly longer than high, regularly rounded on the upper margin or apex obtusely angled; arista black, slightly thickened at base, the pubescence thick but very short, arista reaching to front ocellus; face and cheeks pale yellow, the mouth concave and very slightly keeled in center; cheeks higher pos-

teriorly than anteriorly, at highest part about one-third as high as eye; marginal bristles distinct, 6-7, the anterior pair higher than others; vibrissa strong; proboscis yellow; palpi black, distinctly bristled. Mesonotum subopaque, gray-black, about one-third longer than broad; lateral margins with indications of brownish color, but not yellow; four pairs of long dorso-central bristles present, which are in parallel rows; the anterior pair distinctly in front of suture; four irregular rows of setulae between the dorso-centrals, which are carried to between posterior pair; no distinctly differentiated bristles between posterior dorso-centrals; pleurae marked as in *longipennis*; squamae yellow, faintly brownish; postnotum and scutellum concolorous with disk of mesonotum. Abdomen elongate, shining black, with grayish pollinosity, only the last segment with distinct, very narrow, yellow posterior margin; ovipositor glossy black, base as long as last abdominal segment; segments with numerous short hairs; hypopygium of male rounded, with two flap-like protruding, downward directed, apical organs. Legs black, shining, knees distinctly, but narrowly, pale yellow; mid tibia without posterior bristles. Wings grayish, rather elongate, venation almost as in *longipennis*. Halteres yellow.

Length, 3.5 to 4 mm.

Type: (Male); Cat. No. 15570, U. S. N. M.

Locality: Florissant, Colorado, (7,000 feet level) June 21, 1907, (S. A. Rohwer). Five specimens, two males and three females. Taken amongst grass. There is a female from Colorado in C. W. Johnson's collection and a male in same collection from Eastport Maine.

Food-plant unknown.

24. *Agromyza marginata* Loew.

Syn: *Agromyza marginata* Loew, Dipt. Amer. Sept. Indig. Cent. 8, 1879 species 91.

Male and Female: Frons pale lemon yellow, shining, center stripe opaque black, deepest in color at anterior margin above lunule; ocellar triangle distinct, black, margins narrowly yellow; orbits of nearly equal breadth on their entire length, darkened anteriorly, four orbital bristles anterior to front ocellus, these are on middle of orbits; there are no additional hairs present on any of the specimens before me; antennae brown, of rather less than normal size, dorsal bristles on second joint of moderate size; third joint rounded, barely longer than broad; arista brown, slightly swollen and tapering at base, almost bare, reaching from its base to anterior ocellus in female, slightly shorter in male; face brown, concave in profile, the lower margin at mouth, projecting slightly, center keel indistinct; cheeks yellowish brown, short, gradually deepening from front to back, where they are less than one-fourth the height of the eye; marginal bristles distinct, vibrissa strong; eye distinctly higher than long. Mesonotum slightly longer than broad, glossy black brown; three pairs of dorso-centrals present, the anterior pair weak, disk with numerous distinct

lateral margins and humeri brown; pleuræ glossy brown-black; outer margin and central, vertical, suture narrowly, and a patch below wing base yellow; scutellum distinctly broader than long, concolorous with disk of mesonotum; postnotum concolorous with pleuræ; notum yellow, margin and fringe brown. Abdomen glossy brown, black-brown, posterior margin of last segment sometimes narrowly yellowish; last abdominal segment almost as long as the three preceding segments, ovipositor elongate, glossy black; male hypopygium black, of moderate size, about one-fourth as long as preceding abdominal segment; surface hairs most numerous on the sides of second segment, and longest on apical segments. Legs yellow; basal half of each femur brown-black, apices of tibiae and all tarsi more or less browned; posterior mid tibial bristles absent. Wings grayish; first costal division one-third as long as second, subcostal vein indistinct, but complete, inner cross vein at just below end of first vein, outer cross vein at distinctly more than its own length from inner and at wing middle; first and second sections of fourth vein subequal; penultimate section of fifth vein slightly shorter than ultimate; outer half of last sections of veins 3-4 almost parallel. Halteres clear yellow.

Length, 1.5 mm.

Originally described from District of Columbia (Osten Sacken).

Represented in collection by three specimens, two females and one male, from Beverly, Massachusetts (Burgess). These specimens bear the dates May 28, 1868; August 28, 1869; and May 24, 1874, respectively.

Food-plant unknown.

25. *Agromyza canadensis*, new species.

Plate XXX, Fig. 19.

Female: Frons opaque, brown, sides subparallel, in breadth one-third the width of head and distinctly longer than broad, orbits slightly differentiated, subshining; orbital bristles five in number, situated near outer margin of orbits, decreasing in size from back to front; no hairs on orbits in addition to bristles; ocellar region shining, the anterior ocellus separated more widely from posterior ocelli than posterior ocelli from each other; antennæ yellowish-red, third joint brown; second joint with strong dorsal bristle, and weaker apical hairs; third joint rather elongate, one-third longer than broad, rounded at tip; first joint brown, yellow, and with an elongate swelling at base, pubescence very weak, distinctly shorter than basal diameter of arista, length of arista as long as from its base to between upper two orbital bristles; body in profile perpendicular, yellow, with whitish dusting and distinct blackish line on each side of keel, cheeks linear, only slightly darker at posterior margin than anteriorly, brown, outer on margin; antennal bristles upturned, of moderate strength; vibrissæ strong; the weak bristles are continued upward beyond the level of vibrissæ; labro-cis yellow; palpi brown, slightly spatulate, with distinct bristle.

Mesonotum shining, brown-black on disk, with gray dusting, humeral and lateral margins reddish yellow; five pairs of dorso-central bristles present, the anterior three pairs reduced in size, only the front pair anterior to suture; the pair of bristles between the posterior dorso-centrals very strong; disk with numerous setulose hairs; pleurae brown-shining, sutures and below wing base yellowish; squamae whitish, below, fringe concolorous; scutellum and postnotum concolorous with disk of mesonotum. Abdomen reddish yellow; last segment elongated; base of ovipositor glossy black, slightly longer than preceding abdominal segment; all segments with numerous black bristles and hairs. Legs yellow, stout; posterior side of mid tibia with two long bristles. Wings slightly grayish; costa thickened at end of first vein, first cross division (to near side of first vein) less than one-half as long as next division (from end of swollen junction of first vein with costa; upper end of outer cross vein below a point in costa beyond middle of wing veins 2-3 distinctly, 3-4 hardly divergent; section of fourth vein beyond inner cross vein one and one-half times as long as outer cross vein and distinctly longer than preceding section of fourth; inner cross vein below junction of first vein with costa; last section of fifth vein three-fifths as long as penultimate section; basal part of wing veins clear yellow. Halteres yellow, knob whitish.

Length 3 mm.

Type: Cat. No. 15571, U. S. N. M.

Locality: Cottage Beaulieu, Ottawa, Canada, August 14, 1906, (Germain Beaulieu), one female.

Food-plant unknown.

26. *Agromyza laterella* Zetterstedt.

Syn: *Agromyza laterella* Zetterstedt, Ins. Lapon, 1838, p. 788, species 7.
Agromyza grossicornis Zetterstedt, Dipt. Scand. Vol. XIV, 1860, p. 406.
Agromyza magnicornis Loew, Dipt. Amer. Sept. Indig., Cent. 8, 1899, species 86.

Male and Female: Frons about one-half as broad as head, outer stripe opaque, brownish or blackish, with slight whitish dusting, ocelli shining, four or five orbital bristles anterior to front ocellus, beyond these, laterally, is an irregular row of hairs; frontal humuli with gray dusted, very distinct; ocellar region shining black; antennae thick in male large, third joint very variable both in size and shape, often subquadrate, elongated and truncate at apex, or enlarged and rounded at apex, very thickly covered with distinct, pale pilosity; in female the third antennal joint is much smaller and rounded; arista thick inserted near base of third joint, thickened on basal third, pubescence very short and indistinct, length of arista equal to from its base to second uppermost orbital bristle; head of male slightly produced in front, the frons slightly buccate; face concave; cheeks short, distinctly longer posteriorly than anteriorly, but at highest part not one-fourth as long as eye, marginal bristles distinct; vibrissa well differentiated; palpi yellow; palpi black, normal; occiput unprojecting on upper half. Mesonotum black, slightly shining, indistinctly gray dusted, lateral margins

greenish yellow; four pairs of dorso-centrals present; discal setulae rather strong; the pair of bristles between the posterior pair of dorso-centrals distinct, but not large; pleurae glossy black, narrowly lemon yellow along upper and medium vertical suture, and broadly below wing base; squamae almost white, fringe concolorous; scutellum and pronotum gray black. Abdomen glossy black, or black-brown, posterior margins of segments generally narrowly yellow, sometimes the base of abdomen yellow laterally; hypopygium of male small; anal plate of female glossy black on basal portion. Legs black, or black-brown, knees distinctly pale yellow; mid tibia without distinct bristles on posterior surface, except in one specimen. Wings clear, basal part of thick veins pale yellow; subcostal vein indistinct, but complete; second costal division about $2\frac{1}{2}$ times as long as first; inner cross vein at just before end of first vein, and at about middle of discal cell, last cell section of fifth vein subequal with penultimate section; veins 3-4 slightly divergent on their last sections. Halteres yellow.

Length 1.5-2.5 mm.

Localities of specimens examined: Algonquin, Illinois, (collection Coquillett); Franconia, New Hampshire, (Mrs. A. T. Slosson); Biscayne Bay, Florida, (Mrs. A. T. Slosson); Rosslyn, Virginia, October, 1903, (E. S. G. Titus); Beverly, Massachusetts, June 1, 1868, (Burgess); another same collector and locality, June 2, 1876; Worcester, Mass., "Gall on Iris" (no collector's name); and South Fork, British Columbia, (R. P. Currie). There are specimens in C. W. Johnson's collection from Chester and Framingham, Massachusetts.

This species has been recorded by Thomson,* as feeding galls on blue Iris, and although there is no collector's name on the Worcester specimen mentioned above, it is very probably belongs to the lot reared by him, as Coquillett identified specimens.

This is a very variable species in color, and structure of the antennae, and one might be easily led into considering some of the forms as distinct species. I am, however, convinced from my acquaintance with the species in Britain, that there is but one species, though it probably feeds upon different food plants, as I have met with it in situations where it could not have fed upon Iris.

**Myrmica*. Vol. XIV, 1907, p. 74.

27. *Agromyza maculosa*, new species.

Male and Female: Shining black, frontal lunule silvery white, pollinose; legs with tibiae and tarsi sometimes brownish; halteres white with black spot.

Frons very slightly more than one-third the head width; center stripe opaque; orbits glossy, differentiated from center stripe; ocelli (and occasionally six), strong orbital bristles present; frontal lunule distinct, viewed from above and behind shining silvery white; antennae with second joint brownish, dorsal bristle distinct; third joint of rostrum approximate size, rounded at apex, covered with very short, brownish pubescence; arista brown, distinctly swollen and tapering at base, pubescent, short and close; length of arista equal to from its base to between upper two orbital bristles anterior to ocelli; face shining in center, subopaque on sides, in profile concave; the central keel rounded, not sharp, chelicerae rather short, twice as high posteriorly as anteriorly, marginal bristles rather strong though short, slightly upcurved and continued weakly beyond vibrissa; vibrissa strong, well differentiated; proboscis brownish, yellow; palpi black, of normal size and shape. Mesonotum with four pairs of strong dorso-centrals which are slightly reduced in size from posterior to anterior pairs; five or six rather irregular rows of sculae between the dorso-centrals, the pair of bristles between the posterior dorso-centrals slightly differentiated from the discal sculae; pleurae below wing base slightly yellowish; squamae of rather large size, white, fringes concolorous. Abdomen rather broad, ovate; all segments with short dorsal hairs, stronger on margins laterally and posteriorly, noticeably longer on posterior margins of last two segments; base of ovipositor barely longer than preceding segment. Legs strong, front femur with distinct ventral bristles; mid tibia with the posterior two bristles distinct. Wings with base slightly yellowish; first vein yellowish to end; subcostal vein weak; first costal division one-half as long as second; inner cross vein at below end of first vein; outer cross vein at slightly beyond middle of wing, and at its own length, or slightly more, from inner cross vein; last section of fifth vein distinctly, but not greatly shorter than penultimate section; veins 2 and 3 distinctly 3 and 4 slightly divergent. Halteres white, outer surface of knob and most of stalk blackened.

Length, 3-4 mm.

Type: Cat. No. 15641, U. S. N. M.

Type locality: Jamaica, New York, October, 1896. Bred from chrysanthemum leaves. Paratypes from Louisville, Ky., October 27, 1898; 6 specimens bred from chrysanthemum leaves No. 4064; Lafayette, Ind., October 11, 1901, (H. B. Dörner), 5 specimens bred from leaves of aster; Jamaica, New York, 2 specimens from same lot as type; and one specimen without data from Georgia. One specimen in C. W. Johnson's collection from Bermuda, West Indies.

28. *Agomyza waltoni*, new species.

Plate XXVIII, Fig. 6; Plate XXXI, Fig. 36.

Female: Frons black, center stripe opaque, orbita whitish, dusky at base of bristles; breadth of frons slightly more than one-half the head width, and almost subquadrate; orbits slightly differentiated from center stripe, each at broadest part about one-fourth the breadth of center stripe at same part, orbital bristles five in number, on one side at margin of lunule is another smaller bristle which I take to be abnormal; lunule brownish yellow, covered with white yellowish, cellular region subopaque; posterior ocelli occupying about one-fifth the width of vertex; antennae black, rather below average size, second joint with apical bristles on outer side, the dorsal bristle distinct; third joint rounded, barely longer than broad, not distinctly pilose; antea black, paler at base, swollen on basal fourth, almost bare, in length reaching almost from its base to upper orbital bristle; face and cheeks black-brown; slightly gray dusted; the former in profile almost perpendicular, center raised slightly, but not sharply keeled; cheeks at posterior margin about one-sixth the eye height, anteriorly becoming linear; marginal bristles strong, anterior two higher than vibrissae; vibrissae strong; proboscis yellow; palpi black, slightly spatulate, bristles weak. Mesonotum black, slightly shining, grayish dusted; four pairs of dorso-centrals present, these are reduced in size anteriorly; the setulae between the dorso-centrals in about 10 irregular rows, the two bristles between posterior dorso-centrals distinct, separated from each other by almost twice the distance between them and the dorso-centrals; pleurae black, shining, sutures brownish; squamae brownish yellow, fringe brown; scutellum and postnotum concolorous with pleurae. Abdomen shining black. Sixth segment elongated; base of ovipositor shorter than preceding segment; all segments with numerous hairs, those on apices of segments, and especially the sixth, bristle-like. Legs black, shining; knees brownish; fore femur with long ventral bristles; the posterior bristles on mid tibia present, but very short in type. Wings yellowish brown at base; subcostal vein complete, rather distinct; second costal division slightly more than twice as long as first; inner cross vein slightly beyond end of first vein, outer at length of inner from that vein, and distinctly before wing middle, veins 2-3-4 very noticeably divergent at apices; penultimate section of fifth distinctly shorter than ultimate section. Halteres yellow, knobs whitish.

Length, 4 mm.

Type: Cat. No. 15572, U. S. N. M.

Locality: Long Lake, Adirondack Mountains, (Horvath).
One female.

Food-plant unknown.

Named in honor of Mr. W. R. Walton of the Bureau of Entomology.

29. *Agromyza angulata* Loew.

Plate XXIX, Fig. 16; Plate XXX, Fig. 18.

Syn: *Agromyza angulata* Loew, Dipt. Amer. Sept. Indig., Cent. 8, 1849, species 87.

Male and Female: Frons deep black, with sometimes a slight indication of paler color very narrowly along the inner margin of orbits; central stripe opaque, orbits shining; breadth of frons distinctly over one-third the head width, of orbits about one-half the width of central stripe; generally 5 orbital bristles present; in addition to the bristles there are numerous short hairs nearer to eye margin, forming an irregular row from opposite insertion of antenna to upper bristle; ocular region glossy black; antennae black, of moderate size; dorsal bristle on second joint distinct; third joint rounded at apex; arista brown, basal fifth yellowish and swollen, pubescence very short, length of arista equal to from its base to between upper two orbital bristles; face and cheeks black, or black brown, opaque; the former with a slight central keel, and a little produced at mouth margin; cheeks almost linear, very little higher at posterior margin than at anterior; marginal bristles in a double row, of moderate strength; vibrissa well differentiated; proboscis yellow; palpi black, of normal size and shape. Mesonotum glossy black, lateral margins sometimes brownish; four pairs of dorso-centrals present, the posterior pair strong, the others gradually reduced towards anterior pair, which are rather weak and slightly in front of suture; 7-8 irregular rows of short setulae between dorso-centrals; no distinctly differentiated pair of bristles between posterior dorso-centrals; pleurae glossy black, very narrowly lemon yellow along upper margin to humerus, narrowly along vertical mesopleural suture, more broadly at upper angles of that suture and below wing base; postnotum and scutellum colored as disk of mesonotum, squamae whitish yellow, fringe whitish. Abdomen ovate, glossy black, sometimes with the segments very narrowly pale yellow, or brownish; sixth segment elongated; all segments with numerous surface hairs; apical margin of sixth segment with moderately long bristles; hypopygium of male of moderate size, colored as abdomen, base of ovipositor of female glossy black. Legs black, shining; fore knees pale yellow, knees of hind pairs, fore tibiae and tarsi brownish, or yellowish; mid tibia without posterior bristles. Wings clear, bases of thick veins lemon yellow; first costal division one-half as long as second; outer cross vein below, or slightly beyond end of first vein; subcostal vein indistinct; first two sections of fourth vein subequal, or the first slightly the shorter; last section of fifth twice as long as penultimate section; veins 2-3-4 slightly divergent. Halteres pale yellow.

Length 1.5-2 mm.

Originally described from Pennsylvania (Osten Sacken), and since recorded from New Jersey, (Smith Cat.). Represented in U. S. National Museum collection by four specimens from

Lafayette, Indiana, (P. Luginbill) Webster's No. 9700, reared from timothy grass, and two specimens with the No. 6719, July 13, 1895, District of Columbia. There is one specimen in C. W. Johnson's collection from Auburndale, Massachusetts.

30. *Agromyza setosa* Loew.

Syn: *Agromyza setosa* Loew, Dipt. Amer. Sept. Indig., Cent. 8, 1860, p. 63, pl. 81.

Male and Female: Frons black or black-brown; center stripe opaque; orbits shining; width of frons equal to slightly over one-third the width of head; orbits about one-half as wide as center stripe; five orbital bristles present, situated nearer to inner than outer margin of orbits; in addition to the bristles there are numerous short hairs present, between the eye margins and the bristles, which are particularly numerous on the lower half of orbit and terminate in an irregular row at about level of upper orbital bristle; ocellar region shining; ocellar triangle slightly indicated, shining; antennae black, moderately large; second joint slightly over the average size, with numerous hairs, the basal bristle distinct; third joint rounded at apex, barely longer than broad, covered with short brownish pilosity; arista brown, for a short space paler beyond the distinctly thickened base; pubescence short but distinct, very close; length of arista equal to from its base to the second uppermost orbital bristle; face and cheeks black-brown; the former perpendicular and with a rounded central keel; cheeks increasing in height from anterior to posterior margin, where they are about one-fourth the height of eye; marginal bristles of moderate length, in two rows, and rather numerous, the upper row upwardly directed; vibrissae differentiated; proboscis brown; palpi black, of moderate size, rather numerous bristled; eyes microscopically haired. Mesonotum subshining black; thickly covered with hairs and with four pairs of dorso-central bristles, the anterior pairs much reduced and the front pair not much stronger than the other dorsal hairs; the pair of bristles between the posterior dorso-centrals distinct, and of moderate length; pleurae concolorous with disk of mesonotum, only brownish below wing base; squamae brown, fringe concolorous; postnotum and scutellum colored as pleurae. Abdomen concolorous with thorax; the surface rather thickly covered with hairs; sixth segment with some bristle-like hairs on posterior margin; hypopygium of male almost similar to that of *paricornis*; ovipositor of female with base thickly covered with hairs. Legs black, tibiae and tarsi black brown; posterior bristles on mid tibiae very weak. Wings grayish, veins brown; first costal division nearly one-half as long as second; subcostal vein indistinct, almost rudement with first at its apex; costa thickened at end of first vein; inner cross vein at slightly beyond end of first vein or at just below it; outer cross vein at slightly beyond wing middle, and at slightly more than its own length from inner cross vein; last section of fifth vein about one-half as long as penultimate section; veins 3-4 only slightly divergent at apices. Halteres yellow, stalk darkened at base.

Length 3-4 mm.

Originally described from District of Columbia (Osten Sacken). Represented in U. S. National Museum collection by 3 specimens, one from Monroe, Michigan, no other data; one with the number 2464—, and the third with label to the effect that it was reared from wild rice (*Zizania aquatica* August 8, 1891, District of Columbia, (T. Pergande). The other records given by Coquillett for this species in Bull. No. 10, n. ser. 1898, Dept Agric., Div. Ent. refer to *fragaria* and *maculosa*.

There is a male specimen in the U. S. National Museum collection which represents probably a distinct species, but its condition is not good enough to permit me deciding the question, as the species of the group are all very closely allied.

Locality: San Mateo County, California (C. F. Baker).

31. *Agromyza isolata*, new species.

Female: Frons black-brown; center stripe opaque, orbits shining; breadth of frons a little over one-third the width of head; orbits slightly differentiated from center stripe, and each about one-fourth as wide; four long orbital bristles present, situated about on middle of orbits; the short hairs sparse and in a short irregular row; ocellar region rather shining; ocellar triangle not distinguishable; antennae black-brown; second joint with numerous short, apical marginal hairs, and the dorsal bristle distinct, third joint slightly longer than broad; the upper extremity less distinctly rounded than the lower, covered with rather distinctive pile, which is brownish in color, and most distinct on dorsal surface at apex; arista brown, the swelling at base short and glossy; pubescence very short; length of arista equal to from its base to upper orbital bristle; face brown-black, perpendicular, almost without a central keel; cheeks nearly linear, brown-black; marginal bristles in two rows of moderate strength; vibrissa distinctly differentiated, the bristles continued above level of vibrissa; eye apparently bare, about one and one-half times as high as long; proboscis yellow; palpi black. Mesonotum black, shining, but not glossy; four pairs of distinct dorso-centrals present, the posterior pair most widely placed and strongest, the anterior pair of moderate strength, distinctly longer than discal setulae, and appreciably in front of suture; about 7 irregular rows of setulae between the rows of dorso-centrals; the pair of bristles between the posterior dorso-centrals as long as anterior dorso-central pair; pleurae black-brown, glossy, narrowly paler along upper margin and sutures, yellowish beneath wing base; squamae yellowish white, margin and fringe brown; postnotum and scutellum concolorous with disk of mesonotum. Abdomen ovate in shape, glossy black, apical segment yellowish brown at apex, base of ovipositor longer than preceding segment; hairs on ovipositor yellowish, on abdomen and thorax brownish. Legs yellowish brown, the femora blackened; all legs with num-

cross hairs, which are yellowish in color; mid tibia with the posterior bristles small. Wings clear; second costal division about two and one-half times as long as first; subcostal vein distinct, evidently coalescent with first at apical fourth; inner cross vein at slightly before end of first vein; outer at slightly beyond wing middle, and at one and one-half times its own length from inner; veins 3-4 slightly divergent at apex; last section of fifth vein rather over two-thirds as long as the penultimate section. Halteres yellow, knob whitish.

Length 2 mm.

Type: Cat. No. 15573, U. S. N. M.

Locality: Eureka California, May, (H. S. Barber).

Food-plant unknown.

32. *Agromyza fragariæ*, new species.

Plate XXVIII, Fig. 5.

Male and Female: Frons dark brown, or black brown; center stripe opaque; orbits subopaque; breadth of frons distinctly over one-third the width of head; orbit one-fourth as broad as center stripe; four orbital bristles present, the hairs on orbits not numerous; ocellar region shining black, raised, frontal triangle not distinguishable; antennae black, sometimes with indications of paler color at apex of second joint on inner surface; rather below the average in size; second joint with weak apical hairs, and the dorsal bristle distinct, third joint not longer than broad, rounded in front, and covered with short brownish hairs; arista brown, thickened on basal fourth, the pubescence close, but very short; length of arista equal to from its base to slightly beyond second uppermost orbital bristle; face shining black, perpendicular, but very slight; cheeks pale brown, linear at anterior margin, about one-third as high as eye at posterior margin; marginal bristles in a double row, numerous, of moderate length, extending above level of vertex, which is distinctly differentiated; proboscis yellow; palpi black. Mesonotum subopaque, black, with slight indications of grayish dusting; four pairs of dorso-centrals present, which become shorter towards front, the anterior pair slightly in front of suture; 6-7 irregular rows of setulae between the dorso-centrals; the pair of bristles between the posterior pair of dorso-centrals distinctly differentiated from the dorsal setulae, about as long as anterior pair of dorso-centrals; pleurae shining black-brown, the suture yellowish brown; squamae whitish, space brownish-yellow; postnotum and scutellum black, subshining, beneath shining black, subovate in female, elongate in male; covered with hairs, those on posterior margins of segments bristle-like; the dorsal hairs on abdomen and mesonotum are brownish yellow. Legs rather slender, black-brown, tibiae and tarsi paler; posterior mid tibiae bristles minute. Wings elongate, grayish; first costal division one-half as long as second; subcostal vein rather distinct, almost coalescent with first at its apex; inner cross vein at slightly before end of first vein, but middle of discal cell; outer cross vein at about one and one-half

times its own length from inner and at wing middle; last section of fifth vein about two-thirds as long as penultimate section; veins 3-4 gradually and slightly divergent. Halteres yellow.

Length 1.5-2 mm.

Type: Cat. No. 15574, U. S. N. M.

Locality: Placer County, California, November, mining leaves of strawberry, (A Koebele).

Three specimens.

33. *Agromyza posticata* Meigen.

Plate XXXI, Fig. 29.

Syn: *Agromyza posticata* Meigen, Syst. Besch., Vol. VI, 1830, p. 172 species 16.

Agromyza terminalis Coquillett, Proc. Acad. Nat. Sci. Phil. 1895, p. 418.

Agromyza laeniola Coquillett, Proc. Ent. Soc. Wash., Vol. VI, 1904, p. 156.

Male and Female: Frons black, center stripe opaque, often shining, breadth of frons less than one-third the head width; four orbital bristles below anterior ocellus, small hairs on orbits microscopic in male, strongest in female; lunule silvery white pollinose; antennae brown, of normal size; dorsal bristle on second joint distinct, next of same joint with numerous short hairs, which are most distinct on the under side; third joint rounded, covered with short, pale pubescence, arista brown, pale yellowish on basal elongate swelling, very thick, covered with short pubescence, which is not longer than the basal diameter of arista; arista as long as from its base to beyond upper orbital bristle; eyes microscopically haired, cheeks and face brown, the latter concave in profile, keel slight; cheeks linear at anterior margin, at posterior margin very slightly broadened, marginal bristles 5-7, of moderate strength; vibrissa strong; proboscis yellow; palpi brownish yellow, normal in size, with weak end bristles. Mesonotum glossy brownish-black, margins and humeri pale brown, with indication of yellow along suture between margin of disk and pleurae; three distinct pairs of dorso-centrals present, in one specimen an additional bristle is visible on one side anterior to the front pair; 5-6 irregular rows of setulae between dorso-centrals, the pair of bristles between posterior dorso-centrals distinctly differentiated from setulae but much weaker than dorso-centrals; pleurae glossy brown, yellowish along suture and below wing base; scutellum and postnotum concolorous with disk of mesonotum; squamae whitish, fringe white. Abdomen glossy black-brown; apical three segments and hypopygium of male pale yellow, of female posterior margin of sixth segment distinctly pale yellow; apical segments brownish, ovipositor glossy black; last abdominal segment in male slightly elongated; all segments with numerous short black hairs, the apical segments with unusually weak posterior marginal bristles. Legs brown-black, glossy, knee joints paler; mid-tibia with posterior bristles present, in some cases those number three instead of the normal two. Wings yellow at base; first costal division almost one half as long as second; inner cross-vein at below, or slightly beyond, end of first vein; subcostal vein indistinct, but complete

outer cross vein at slightly beyond wing middle, and at rather more than its own length from inner cross vein; last section of fifth vein about two-thirds as long as penultimate section; veins 2 and 3 distinctly, 3 and 4 slightly divergent at apices. Halteres yellow, knob whitish.

Length 3-4 mm.

Localities of male specimens in collection: Delaware county, Pennsylvania, July 23, 1893 (collection Coquillett), the type of *terminalis* Coquillett; Franconia, New Hampshire, (Mrs. A. T. Slosson); White Mountains, New Hampshire (Morrison); District of Columbia, June (collection Coquillett); Oswego, New York, July 7, 1897; and Athens, Tennessee, August, (H. S. Barber).

The female has the apical abdominal segments so much less distinctly pale than the male, that it is with difficulty one associates it with that sex. So dissimilar are the sexes that Coquillett in describing *terminalis* failed to associate with the male two females taken at the same time and place.

It was this sex which he recorded* as *neptis* Loew, from Chicago. There are females in collection from Delaware county, Pennsylvania, Plummers Island, Maryland, August 3, 1912 (J. R. Malloch); Georgia (no other data); and a specimen reared from mine in leaves of Solidago, July 20, 1884, Virginia (T. Pergande). I have also seen a male and female taken by W. L. McAtee, on Plummers Island, Maryland; and specimens in C. W. Johnson's collection from the following localities: Hanover, New Hampshire; Machias, Maine; Eastport, Maine; Chester, Massachusetts; Winnipauk, Connecticut; Danbury, Connecticut, Rowayton, Connecticut; Buttonwoods, Rhode Island; Norwich, Vermont, and Cornish, New Hampshire. The type specimen of *taeniola* Coquillett is a male of this species.

A peculiarity about this species is that after death the eyes are red, whereas in practically all the other species they become brown or black.

34. *Agromyza neptis* Loew.

Syn. Agromyza neptis Loew, Dipt. Amer. Sept. Indig., Cent. 8, 1869, species 93.

Male: Frons black, one-third as wide as head; center stripe opaque black; orbits glossy, each orbit about one-third as wide as center of eye; four orbital bristles present, the hairs on orbits in an irregular line between bristles and eye margin; ocellar region raised, glossy; antennæ black, rather above the average size; second joint

*Bull. 10, n. ser., 1898, Dept. Agric. p. 78.

with rather weak dorsal bristle, and weak apical marginal hairs; first joint large, distinctly longer than broad, covered with distinct pile; arista brown, tapering, distinctly and thickly covered with pubescence, which is about as long as basal diameter of arista; length of arista equal to three times the length of third antennal joint; labrum subshining, black, rather long, concave in profile, central keel sharp but sharp; cheek black, almost linear, slightly higher at posterior margin. Marginal bristles weak; vibrissa weakly differentiated, distinctly higher than long; proboscis yellow; palpi black; legs black. Mesonotum glossy black, thickly covered with rather long hairs; three pairs of dorso-centrals present, the anterior pair weak; the bristles between the posterior dorso-centrals as long as second pair of dorso-centrals; pleurae glossy black, with a slight indication of yellow color along upper margin, and distinctly pale below wing base; apical yellowish white, fringe white; postnotum and scutellum concolorous with mesonotum, the apical pair of bristles on scutellum as strong as basal pair. Abdomen glossy black, similar in shape to that of *vicornis*. Wings clear; first costal division almost one-half as long as second, inner cross vein at slightly beyond middle of wing and distinctly more than its own length from inner; last section of fifth vein distinctly shorter than penultimate section. Halteres white.

Length 2 mm.

Originally described from District of Columbia (O. Sacken). Aldrich gives it as from Nebraska, but probably refers to another record of the species. I have before me only one specimen which is referable to this species.

Locality: Plummers Island, Maryland, August 3, 1912 (J. R. Malloch).

Food-plant unknown.

35. *Agromyza inconspicua*, new species.

Male: Frons slightly over one-third the width of head; black center stripe opaque, orbits and ocellar region shining; four orbital bristles present, orbits otherwise almost entirely bare; antennae black, brownish at base; third joint small, rounded, not as long as head; arista slightly swollen and tapering at base, pubescence very short, length of arista equal to from its base to upper orbital bristle; labrum black, concave in profile, slightly produced at mouth margin; central keel rounded; cheek brownish yellow, twice as high at posterior as at anterior margin, at highest part one-third as high as eye; vibrissae of moderate strength, vibrissa slightly differentiated; proboscis yellow; palpi black; occiput linear on upper half. Mesonotum shining black, three pairs of dorso-centrals present, the anterior pair weak and anterior to the suture a setula which may, in other specimens, be strong enough to be classed as a dorso-central; disk very sparsely covered with setulae, only three irregular rows between the dorso-centrals; no distinct bristles between the posterior pair of dorso-centrals; pleurae

gray black, median vertical suture narrowly pale yellow; scutellum opaque, brownish-black; apical pair of scutellar bristles strongest. Abdomen rather narrow; shining black-brown; hypopygium normal in size. Legs black-brown, knees distinctly yellow; tarsi yellowish brown, no distinct bristles on posterior surface of mid tibia. Wings narrow, clear, veins on basal half pale yellow; costa brown, first division about half as long as second; inner cross vein at distinctly anterior end of first vein and middle of discal cell; outer cross vein at discal middle more than its own length from inner and very slightly before middle of wing; veins 3-4 on last sections almost parallel; last section of fourth vein about one-fourth longer than penultimate section. Halteres yellow, knob whitish.

Length slightly over 1 mm.

Type: Cat. No. 15575, U. S. N. M.

Locality: Fort Collins, Colorado, reared from mine in *Agropyron*, July 28, 1910, (C. N. Ainslie). Webster's No. 6611.

36. *Agromyza dubitata*, new species.

Female: Frons black, center stripe opaque, orbits shining at base of bristles; breadth of frons a little over one-third the width of head; of each orbit about one-half the width of center stripe; four rather weak orbital bristles present, situated on near to inner margin of orbit; the orbital hairs less numerous than in *californiensis*; ocellar region shining black, raised, the ocelli in an equilateral triangle; antennae black, rather smaller than in preceding species, the third joint rather regularly rounded at apex on upper surface; arista similar to *californiensis*, but slightly shorter; face brown-black, opaque, concave in middle; cheeks brown, almost as in preceding species; proboscis yellow; palpi spatulate, with several moderately strong end bristles, rather narrow on upper half. Mesonotum shining black, bristled as in preceding species, but the pair of bristles between posterior pair of laterals shorter and more widely placed; pleurae squamous, posterior and scutellum as *californiensis*. Abdomen shining black; ovate; bristled with the hind marginal bristles moderately strong. Legs almost entirely black, the knees brownish, or the tibiae and tarsi brown. Halteres yellow, knob paler.

Length 3-4 mm.

Type: Cat. No. 15576, U. S. N. M.

Locality: Beverly, Massachusetts, July 19, 1869, (Burgess). Other localities: Cottage Beaulieu, Ottawa, and Ile St. Jacques, Montreal, Ottawa, Canada, June and July, 1906. Nine specimens.

Food-plant unknown.

37. *Agromyza parvicornis* Loew.

Plate XXIX, Fig. 11; Plate XXXI, Figs. 35, 37.

Syn: *Agromyza parvicornis* Loew. Dipt. Amer. Sept. Indig., Cert. 8, 1892, species 92.

Male and Female: Frons black or black-brown, opaque, often slightly shining, black, four orbital bristles present; orbits differentiated from center stripe, bristles situated nearer inner than outer margin of orbits, a few weak hairs in an irregular row laterally beyond them; antennae brown or brownish black, rather below the normal size, third joint short, rounded in front, thickly covered with soft, short, whitish pilosity; arista brown, generally yellowish near base, except on the short thickened portion which is glossy black; pubescence very close, generally distinct; length of arista equal to from its base to upper orbital bristle; face brown, nearly perpendicular in profile, the central keel slight; cheeks brown, or yellowish brown, very much higher posteriorly than anteriorly, at highest part one-third as high as eye; marginal bristles numerous; vibrissa differentiated, but not very strong; proboscis brown; palpi black, very slightly dilated, weakly bristled. Mesonotum glossy black; disk thickly covered with short setulae; two pairs of dorso-centrals present; the bristles between the posterior pair distinct. Pleurae, scutellum and postnotum concolorous with disk of mesonotum, pleural sutures rarely, and beneath wing bases generally yellowish. Squannae whitish yellow, fringes brown. Abdomen colored as thorax, hypopygium of male as Fig. 35, Plate XXXI. Legs black, the tibiae and tarsi sometimes paler, brownish yellow, most distinct on knee joint, mid tibia with the posterior bristles distinct. Wings clear, slightly grayish on anterior half; venation as in figure, halteres yellow, the knob whitish.

Length 3-4 mm.

Originally described from District of Columbia, (Osten Sacken). Larva lives in mines in leaves of corn; occurs in the following states: Florida, District of Columbia, Indiana, Vermont, Maine, Massachusetts, Connecticut, New Hampshire, Wisconsin, Alabama, South Carolina, Illinois and Texas. Probably generally distributed throughout the United States. A full list of localities will be given in the bulletin in preparation dealing with the economic importance of this species and several others affecting field and forage crops.

38. *Agromyza viridula* Coquillett.

Agromyza viridula Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 190.

Prothorax: Pronotum black, center stripe opaque, orbits distinctly differentiated, shining; breadth of head one-third, or slightly over one-third the head width; each orbit about one-fourth as wide as center of head; four strong orbital bristles present, and beyond these, laterally, a subregular row of short hairs; lunule white pollinose; ocellar region shining black; antennae of moderate size, second joint with distinct basal bristles and very weak apical hairs; third joint rounded, not longer than broad, covered with very short, whitish pile; arista thickened apically, tapering on basal third, bare, as long as from its base to anterior ocellus; face black, opaque, concave in profile, mouth margin slightly produced, keel very slight; cheek linear at anterior margin, anterior margin about one-sixth as high as eye, marginal bristles moderately strong, increasing in length towards anterior margin; clypeus differentiated; occiput not visible on upper half; proboscis slender; palpi black, of moderate size, the bristles distinct. **Mesonotum:** Glossy black; the pair of bristles between posterior pair of dorso-centrals well defined; pleurae glossy black, brownish below wing base; squamae whitish, fringe white; bristles on scutellum subequal. **Abdomen:** Glossy black, with a distinct brassy sheen, ovate, bristled as in *parvula*. **Legs:** shining black; tarsi brownish; mid tibia with posterior pair of bristles distinct. **Wings:** clear, veins black-brown; second basal division $2\frac{1}{2}$ times as long as first; subcostal vein distinct; first fifth first at its apex; inner cross vein at slightly before end of first vein, and distinctly before middle of discal cell; outer cross vein at wing middle, and $1\frac{1}{2}$ times its own length from inner cross vein; last section of fifth vein little over one-half as long as penultimate section, sixth vein distinctly short of wing margin. **Halteres:** with yellow stalk and white knob.

Length 2.5-3 mm.

Re-described from type specimen (Cat. No. 6660, U. S. N.M.)

Locality: District of Columbia, June, (collection Coquillett). The other specimens in collection are from District of Columbia, July; Maryland, June; Georgia; Beverly, Mass.; June 29, 1876, (Burgess); and three specimens from the West Indies in poor condition that probably belong to this species, Aguadilla, and Mayaguez, Porto Rico, (A. Busck), and St. Domingo, (A. Busck). These specimens are slightly smaller than the type, but have no distinctive characters by which they may be separated. I have also seen one specimen submitted by Prof. Chittenden of the Bureau of Entomology, El Paso, Texas, June, 1907 (E. S. Tucker) No. 561. There are also specimens in Prof. Webster's material labelled "Reared from a blotch mine red oak leaf, June 20, 1912." Lafayette, Louisiana, (J. J. Davis).

39. *Agromyza salicis*, new species.

Plate XXIX, Fig. 15.

Male: Frons black, center stripe opaque brown-black, ocellar and ocellar region shining; width of frons about one-half the head width; each orbit about one-half as broad as center stripe; five distinct orbital bristles present, the hairs between these and the eye margin rather conspicuous and numerous; antennae black; rather small, second joint rounded, distinctly shorter than broad; arista brown, swollen on basal fourth; pubescence very short, but distinct; length of hind tarsus not as long as from its base to second uppermost orbital bristle; palpi black, subopaque, retreating towards mouth margin; cheek brown, black, distinctly higher at posterior than at anterior margin, at latter point more than one-half as high as eye; marginal bristles of moderate strength; vibrissa hardly differentiated; proboscis yellow; palpi black, of moderate size. Mesonotum shining black; three distinct pairs of dorso-centrals present; the anterior pair distinctly weaker than the other two pairs, and close to suture; the pair of bristles between the posterior pair of dorso-centrals weakly differentiated; pleurae shining black, brownish along sutures and below wing base; squamae opaque, fringe dark brown; scutellum and postnotum concolorous with disk of mesonotum, the former with the bristles subequal. Legs black, mid tibia without distinct posterior bristles. Abdomen black-shiny, shining, covered with short setulae; hypopygium glossy black, small. Wings rather narrow; second costal division $2\frac{1}{2}$ times as long as first; subcostal vein distinct; fused with first at its apex; inner cross vein at about apex of junction of first vein with costa; outer cross vein distinct, but not greatly, before wing middle, and at slightly more than its own length from inner cross vein; last section of fifth vein subequal with penultimate section; sixth vein indistinct. Halteres black.

Length 2 mm.

Type: Cat. No. 15577, U. S. N. M.

Locality: Reading, Massachusetts, May 16, 1908. New York State Collection, from Willow, (E. P. Felt). One male.

40. *Agromyza winnemanæ*, new species.

Female: Deep black, glossy; abdomen with an indication of metallic bluish sheen. Frons deep black, center stripe opaque, ocellar region glossy; width of frons slightly more than one-third the head width; each orbit a little less than one-fourth the width of center stripe; four orbital bristles present; an irregular row of weak hairs between eye and orbital bristles; antennae of moderate size; second joint with distinct dorsal bristle; third joint barely longer than broad, rounded at apex; arista swollen at base, tapering, bare, in length equal to from the base to second uppermost orbital bristle; face brownish black, opaque, almost perpendicular in profile, with slight, rounded keel; cheek vein short, almost linear, not over one-eighth as high as eye, margin

weak; vibrissa distinctly differentiated though not very strong; labella brown; palpi black, normal; occiput linear, the eyes very large and occupying nearly the whole side of head. Mesonotum with two pairs of dorso-centrals; disk covered with short setulae; the pair of setulae between the posterior dorso-centrals not differentiated from the other discal setulae; squamae yellowish brown, fringe brown; apical bristles on scutellum weaker than the basal pair. Abdomen with segments covered with short setulae, those on the posterior margin slightly stronger; sixth segment slightly elongated; base of ovipositor not as long as preceding segment. Legs shining black; posterior margin of mid tibia, in type, without any bristles. Wing clear, anal and costal division a little over twice as long as first subcostal; veins distinct, coalescent with first at its apex; outer cross vein at middle before wing middle, and at its own length from inner; fourth cross-vein indistinct from outer cross vein to apex; last section of fifth distinctly, but not greatly, longer than penultimate section; costa not reaching beyond end of third vein. Halteres black.

Length 3 mm.

Type: Cat. No. 15578, U. S. N. M.

Locality: Plummers Island, Maryland, June 27, 1909, (W. L. McAtee), one female.

Food-plant unknown.

41. *Agromyza simplex* Loew.

Agromyza simplex Loew, Dipt. Amer. Sept., Cent. 8, 1869, species 84.

Male and Female: Entirely shining black. Frons occupying distinctly more than one-third the width of head; center stripe opaque; sides glossy; ocellar region glossy; the frontal triangle distinguishable, but not separated from center stripe by an impressed line; five orbital bristles present, in addition to those there are numerous soft hairs covering the entire surface, laterally, beyond the bristles, and stretching from opposite base of antennae to upper orbital bristle; antennae rather thick, second joint with moderately long dorsal bristle; third joint pubescent, with very short, whitish pile; arista bare, the base swollen, length of arista equal to from its base to between uppermost two orbital bristles; face slightly keeled, concave in profile, opaque brown; cheeks opaque brown; orbits carried almost to hind margin of face; height of cheek at anterior margin less than at posterior, height is about two-fifths as high as eye; marginal bristles rather short, upturned; vibrissa weakly differentiated; proboscis brown; palpi black, normal. Mesonotum covered with short setulae; two pairs of dorso-centrals present, and in addition to these there are generally 2-3 setulae anterior to them stronger than the discal setulae; squamae black-brown, fringe concolorous; scutellum with the apical two bristles weaker than the basal two. Abdomen broadly ovate in female, somewhat narrower in male; no metallic sheen visible; penultimate segment in female elongate; apical bristles on segment not conspicuous; base of ovipositor not longer than preceding

segment; male hypopygium exposed, rather small. Legs entirely black; mid tibia with the posterior bristles present, but weak. Wings grayish; veins black; subcostal vein indistinct, joining first vein near its apex; first costal division half as long as second; inner cross vein at below end of first vein; outer cross vein at about one-half its own length from inner; last section of fifth vein slightly longer than penultimate section. Halteres black.

Length 2.5-3 mm.

Originally described from the Middle States. Recorded in the Smith Catalogue for New Jersey, and from New York in Bull. 189, N. Y. Exper. Sta. 1900. Represented in collection by two specimens from Berlin, Germany, (C. Schiner) labeled *Agromyza schineri* Loew, in Coquillett's handwriting. The only other specimen I have ever seen was reared from asparagus by I. J. Condit, Portsmouth, Virginia, submitted by Prof. Chittenden of the Bureau of Entomology.

This species attacks asparagus and in the New York Bulletin above mentioned is an account of its life history. Girault has found it in France, and Collin† in England, associated with the same plant.

42. *Agromyza vibrissata*, new species.

Plate XXVIII, Fig. 2; Plate XXX, Figs. 24, 25.

Male: Frons opaque brown-black, only the orbits and occipital triangle slightly shining; breadth of frons nearly one-half the head width; six orbital bristles present, the lower, or anterior, two being close to surface of the frons, which is rather buccate, and pointing backward and slightly inward; numerous closely placed short hairs on frons between bristles and eye margin; lunule depressed; face sunk in and with a central keel, which is raised on a level with eye orbits; antennae brown, rather small and half hidden in face cavities; arista yellowish-brown, distinctly swollen at base, bare, not three times as long as third antennal joint; face black, a yellowish brown patch on center of epistome; epistome much produced; cheeks brown; eye orbit distinct; cheek, including orbit, two-fifths as high as eye; marginal bristles weak, vibrissa formed of a fasciculus of bristles, which is about one-fifths as long as length of cheek; proboscis yellowish-brown, tip black, slightly spatulate, and weakly bristled. Mesonotum shining black; covered with short setulae and with two pairs of dorso-central bristles; the pair of bristles between the posterior dorso-centrals not differentiated; pleurae glossy brown-black, the sutures, and below with base paler; the normal bristles present, squamae yellowish, shining brown; scutellum, and postnotum concolorous with disk of mesonotum; the former with the posterior pair of bristles slightly reduced.

*Bull. Soc. Ent. France, 1894, p. 179.

†Ent. Mon. Mag., Vol. XXII, 1911, p. 254.

males. Abdomen glossy black; all segments with numerous short hairs on dorsum; those on lateral margins of segments longer, the posterior margin of last abdominal segment not noticeably bristly; last segment slightly elongated; hypopygium small. Legs black-brown, shining, tibiae and tarsi paler; posterior bristles on mid tibia present, but not large. Wings clear; veins brown; first costal division only one-half as long as second; subcostal vein indistinct, fused with first at near apex; inner cross vein below swelling caused by junction of first vein and costa; outer cross vein at wing middle, and at nearly its own length from inner; last section of fifth vein slightly shorter than penultimate section. Halteres black.

Length 3.5 mm.

Female: Similar in color and size to the male, but the cheeks as in figure 25; the last segment of abdomen has the bristles at apex stronger than in the male; and the ovipositor is glossy black.

Type: Cat. No. 15579, U. S. N. M.

Locality: Georgia, no other data on specimens. Two males, one female.

Food-plant unknown.

43. *Agromyza affinis*, new species.

Female: Frons black, center stripe opaque, orbits shining, breadth of frons slightly over one-third the head width; orbits less than one-half the width of center stripe; four strong orbital bristles present, on both sides there is a weaker bristle close under the front one; hairs on orbits, between bristle and eye margin, short, but numerous, on front half of orbit; antennae black, of moderate size; second joint with distinct dorsal bristle; third joint rounded, pilosity very short, dark; arista black, basal swelling slight and tapering, pubescence very short and close; length of arista equal to from its base to a little beyond second uppermost orbital bristle; face black, opaque, concave in profile, mouth margin produced, keel distinct; cheek black, brown on lower half, higher anteriorly than posteriorly, vibrissa very clearly differentiated from the marginal bristles; proboscis brown; palpi in type retracted. Mesonotum shining black; two distinct pairs of dorso-centrals present; disk covered with short setulae, which are carried back beyond the transverse line of the posterior pair of dorso-centrals; pleurae shining black, brownish along sutures and below wing base; suture brown-black, fringe almost black; scutellum concolorous with disk of mesonotum. Abdomen glossy black; all segments with discal setulae; those on posterior margin of sixth segments most noticeable, but not strong; base of ovipositor distinctly longer than preceding segment, its surface covered on the sides and apex with short hairs. Legs entirely black, shining; posterior surface of mid tibia without distinct bristles. Wings grayish, veins brown; outer cross vein at distinctly less than its own length from inner, and at wing middle; last section of fifth vein distinctly shorter than the penultimate section. Halteres black.

Length 2 mm.

Type: Cat. No. 15580, U. S. N. M.

Locality: Glen Echo, Maryland, June 3, 1898 (R. P. Currie). This species comes very close to the European *curvipalpis* Zetterstedt, but the two males of that species in collection (Bonhill, Dumbartonshire, Scotland, May, 1907, 1908, J. R. Malloch) have the arista bare, the basal swelling much more pronounced, and elongate; the frons half as broad as width of head; the last section of fifth vein about equal to the penultimate section, and the outer cross vein before wing middle. It may be well to indicate here that the name *curvipalpis* (Dipt. Scand. Vol. 7, 1848, p. 2782, species 44) was given to this species because of a misapprehension on the part of Zetterstedt, who mistook the vibrissæ for a prolongation of the palpi. Schiner in Fauna Austriaca followed him in this respect. The species was afterwards described by Kaltenbach as *bicornis* (Pflanzenf. 1873, p. 330, species 33).

In the collection are three specimens which may be males of *affinis*, but their condition is so poor that I do not consider it desirable to either place their description on record as such, or describe them as belonging to another species.

The localities are, Key West, Florida, January 1 and February 6, 1869, (Hubbard-?) and one from North Carolina, without other data.

Food-plant unknown.

44. *Agromyza insularis*, new species.

Plate XXXI, Fig. 38.

Male and female: Frons black; center stripe opaque, orbits and the weakly defined ocellar triangle shining; breadth of frons in female barely one-third as wide as head, in male slightly wider; each orbit equal to about one-fourth the width of center stripe; four rather weak orbital bristles present; in addition to the bristles there is an irregular row of very short hairs nearer to eye margin; frons in profile declivitous, not projecting; antennæ brown-black, small; third joint not as long as broad, rounded in front, distinctly pilose; arista black, basal third thickened, tapering, almost bare, length equal to from its base to second uppermost orbital bristle; face black, concave, mouth margin slightly produced; cheek black-brown, narrow, almost linear at posterior margin, distinctly higher anteriorly, but not very much produced; vibrissa in male fasciculate in form, the length not equal to that of cheek, and not very conspicuous; in female the vibrissa is distinct and almost as long as in male, but consisting on only one bristle; marginal cheek bristles much weaker than vibrissa; proboscis brownish

yellow at apex; palpi black, rather short and slightly spatulate, the bristles weak; occiput linear. Mesonotum shining black; two pairs of dorso-centrals present; the discal setulae very sparse behind anterior pair of dorso-centrals, and not carried to level of transverse line of posterior dorso-centrals; pleurae glossy brown or blackish, margin and fringe black-brown; scutellum concolorous with disk of mesonotum, the bristles subequal. Abdomen glossy black; ovate; segments with numerous short setulae, posterior margins with more distinct bristles; setulae; base of ovipositor glossy black. Legs black. Wings grayish; veins black-brown; second costal division slightly more than twice as long as first; subcostal vein indistinct, coalescent with first at its apex; inner cross vein at below end of first; outer at its own length from inner, and at slightly before wing middle, last section of fifth vein barely longer than penultimate section; veins 3-4 slightly divergent on last sections. Halteres black.

Length barely 1.5 mm.

Type: Cat. No. 15581, U. S. N. M.

Locality: Cayamas, Cuba, December (E. A. Schwarz).
Male and female, taken in cop.

45. *Agromyza texana*, new species.

Male and Female: This species is very similar to *insularis* in general appearance, but differs as follows: The arista is not so much swollen at base, nor for such a long distance; the cheek is much more distinctly produced in both sexes, and comparatively higher anteriorly; the vibrissa is much more conspicuous in the male, and as long as cheek length, in female the vibrissa is comparatively weak and not nearly so long as in male, consisting of one hair only; the thorax is more densely covered with setulae, which are carried at least to level of transverse line of posterior dorso-centrals; the legs are black in both sexes and the posterior bristles are absent from mid tibiae; the wings have the outer cross vein at wing middle, or very slightly beyond it, and the last section of fifth vein slightly shorter than penultimate section.

Length 1.5-2 mm.

Type: Cat. No. 15582, U. S. N. M.

Locality: Brownsville, Texas, January 27, 1909 (McMillan and Marsh). reared from *Roripa*. One male.

Paratypes: Cabin John Bridge, Maryland, April 28, 1912, two females (Knab and Malloch); Brownsville, Texas, January 27, 1909, one female, same data as type; and one female (Witch, Virginia, June 9, 1912 (F. Knab).

46. *Agromyza abnormalis*, new species.

Plate XXIX, Fig. 9.

Female: Frons black-brown; center stripe opaque; orbits black, shining; breadth of frons over one-third that of head; orbits at widest part one-third as wide as center stripe at that part; five strong orbital bristles present, and in the type a weak one anterior to the lower strong one; upper two bristles situated near to inner margin of orbits, the others nearer to center; besides the bristles there are scattered short hairs present on the orbits nearer to eye margin than bristles; ocellar region raised, shining black; ocellar triangle not defined; frons in profile slightly protruding anteriorly; antennae black-brown, of moderate size; dorsal bristle on second joint distinct; third joint rounded in front, slightly longer than broad, pilosity very short; arista rather thick, swollen more distinctly on basal fifth, pubescence short, but distinct; length of arista equal to from its base to upper orbital bristle; face shining black, slightly retreating, mouth margin not produced, center keel very slight; cheek opaque brown, half as high anteriorly as posteriorly, where it is half as high as eye; marginal bristles of moderate length; the vibrissa slightly differentiated; proboscis yellow; palpi black, normal; occiput slightly projecting. Mesonotum black, subshining; four pairs of dorso-centrals present, the anterior pair in front of suture, discal setulae numerous and rather regularly arranged in rows, of which there are about five between the dorso-centrals; no differentiated bristles between posterior pair of dorso-centrals; pleurae shining black, the sutures and below wing base brown; squamae gray-brown, margins black-brown, fringe brown; scutellum concolorous with disk of mesonotum, the bristles subequal. Abdomen black, glossy; segments rather strongly setulose; ovipositor very glossy black. Legs black, tibiae and tarsi brownish; mid tibia without posterior bristles. Wings grayish; first costal division distinctly over one-half as long as second; subcostal vein indistinct, but complete, not fused with first at its apex; inner cross vein distinctly, but not greatly in front of end of first vein, and at or slightly beyond middle of discal cell; outer cross vein at about its own length from inner and very slightly beyond end of first vein; veins 3-4-5 gradually and slightly divergent on their last sections; last section of fifth vein twice as long as penultimate section. Halteres brown.

Length 3 mm.

Type: Cat. No. 15583, U. S. N. M.

Locality: Washington, District of Columbia, June, 1903. No. 9727—"on Aphid"—"On roots of Amaranthus."

Paratype: labeled "Twilight" Lawrence, Kansas, (E. S. Tucker).

47. *Agromyza virens* Loew.

Dipt. Amer. Sept. Indig. Cent. 8, 1869, species 84.

Male and Female: Frons black, orbits and ocellar triangle glossy, center stripe opaque; breadth of frons slightly over one-third that of head; breadth of orbits over one-third that of center stripe; five orbital bristles generally present, the orbits densely covered with short, fine, hairs; frons generally slightly buccate; antennae brown-black, of moderate size; third joint rounded; arista slightly swollen at base, very thickly, but shortly pubescent; as long as from its base to upper orbital bristle; face concave in profile, brown-black; cheeks higher at posterior than anterior margin, at highest part about one-fourth as high as eye; marginal bristles of moderate strength; vibrissa differentiated; proboscis brown, palpi black, normal; occiput slightly projecting; eyes generally distinctly and thickly pubescent above. Mesonotum glossy black, with sometimes a bluish or greenish tinge; squamae white, or yellowish, the margin yellowish, fringe pale yellowish, or white. Abdomen glossy black, generally with a metallic tinge, either bluish, greenish, or gray; in shape and vestiture as in *tillie*. Legs as in *tillie*; the posterior mid tibial bristles distinct. Wings grayish, or almost clear, venation almost as in *tillie*.

Length 1.5-2.5 mm.

Specimens from Lafayette, Indiana (F. M. Webster). Mining in roots of clover. There are five other specimens in collection with Webster's No. 10,073, from Lafayette, Indiana; one from Gladbrook, Iowa, February 14, 1890, (No. 1608) mining in stems of *Ambrosia artemisiæfolia* (A. M. Sharp); two from Cambridge, Massachusetts, "mining in stems of a weed" (H. G. Hubbard); one marked 30420, referred to as a Tachinid in notes, from stem of a weed in which some species of Cecidomyid was mining, April 18, 1883 (locality doubtful); two specimens labeled "Parasitic on Cecidomyid on aster with yellow flowers," May 23, 1884 (locality doubtful); two from stems of *Ambrosia*, March, 1895, District of Columbia, one from *Nabulus albus*, May 14, 1883 (locality doubtful); two from California (Alameda and Los Angeles), collection Coquillett; one from Georgia, no other data; one from Flagstaff, Arizona, July, (H. S. Barber). One from Plummers Island and four from Washington. D. C. are in the collection of W. L. McAtee and a series of 13 specimens from the Brodie collection are in the U. S. National Museum collection, locality Toronto, Ontario, Canada.

In some cases, I believe with specimens which have been on the wing, it is not very easy to see the hairs on the eyes, but in freshly emerged examples these are very noticeable on

the upper surface of the eyes close to the orbits. A single specimen from Claremont, California (Baker), may belong to a distinct species.

48. *Agromyza cærulea*, new species.

Plate XXIX, Fig. 13.

Female: Frons black; center stripe opaque brown-black, orbits and ocellar triangle glossy black; width of frons equal to slightly more than one-third that of head; each orbit slightly less than one-fourth the breadth of center stripe; four strong orbital bristles present, the orbital pubescence not very conspicuous; frontal triangle fairly well defined, reaching over three-fourths of the way to lunule; lunule shining, bronzy, with indications of whitish pollinosity; antennæ small, black, dorsal bristle on second joint long; third joint not longer than broad, rounded at apex, pilosity pale, very short; arista thickened and tapering on basal fourth, pubescence distinct, slightly longer than basal diameter of arista, length of arista equal to from its base to upper orbital bristle; face short, black, concave in profile; cheek short, shining black, marginal bristles very numerous, strong, and irregularly arranged, not in a single row, carried upward beyond the level of the weakly differentiated vibrissa; proboscis yellow at apex; palpi black, numerously bristled; occiput not produced. Mesonotum glossy blue-black, inclining to brown-black on lateral margins; two distinct pairs of dorso-centrals present; disk covered with numerous short setulae; no discal bristles between the posterior dorso-centrals; pleurae glossy blue-black, sutures and below wing base brown; squamæ white, fringe concolorous; scutellum concolorous with disk of mesonotum, the marginal bristles subequal. Abdomen ovate, bronzy blue-black; first two segments short, the others subequal, all segments with short discal setulae, those on posterior margins of segments strong; base of ovipositor not longer than preceding segment. Legs strong, especially the femora, which are thickened; black, shining, tibiae at base brownish; fourth with a strong bristle on posterior surface at below middle; the posterior bristles on posterior surface of mid tibia strong. Wings clear, yellowish brownish yellow; second costal division about twice as long as first subcostal vein indistinct; outer cross vein at slightly below wing middle and at a little more than its own length from margin to wing on both vein, and from inner cross vein; veins 2-3 divergent, 3-4 slightly convergent at apices; inner cross vein at below junction of first vein with costa, and at middle of discal cell. Halteres black, pedicel yellowish brown. Length 3-4 mm.

Type: Cat. No. 15584, U. S. N. M.

Locality: The specimen bears the M. S. label "S. J. Allende, Mexico," and the numbers 11-29, which probably means that it was taken on November 29. I cannot find on the available maps of Mexico any locality in accordance with that on the label. No collector's name is given. One specimen.

Food-plant unknown.

49. *Agromyza burgessi*, new species.

Plate XXXI, Fig. 31.

Female: Frons black; center stripe brown-black, opaque; orbits black; width of frons distinctly, but not greatly, over one-third the width of head; breadth of each orbit about equal to one-fourth the width of center stripe; generally six strong orbital bristles present, in one specimen five only; the bristles situated on margin no longer than outer margin of orbits; the space between eye margin and bristles thickly covered with short hairs; ocellar triangle poorly defined anteriorly, the gloss on surface not continuing to its apex; humuli whitish; frons projecting slightly anteriorly, giving the head a somewhat laccate appearance; eye orbit continued to almost hind angle of eye; glossy black; antennae small, brown; third joint not longer than broad, regularly rounded at apex; arista swollen at base, bare, as long as from its base to between second and third uppermost orbital bristle; dark brown, distinctly higher at posterior than at anterior margin, and at highest point distinctly over one-third the height of eye; marginal bristles of moderate strength, not numerous; vibrissae well differentiated; proboscis brown; palpi black, slightly spatulate, weakly bristled at apex; occiput distinctly visible on upper half. Mesonotum black, glossy, without any distinct bluish fringe; bristles as in *carulea*; pleurae brown-black, the sutures and below wing base pale brown; squamae grayish, margin black-brown, the fringe brown; scutellum black, glossy; bristles subequal. Abdomen glossy black or brown black, with, in some lights, a bronzy luster; second segment not so distinctly bordered as in *carulea*; in other respects similar to that species. Legs similar to previous species, but the bristle on fore tibia is weaker. Wings in most respects similar to *carulea*, but the third and fourth veins distinctly divergent on their outer sections. Halteres brown.

Length 3.5-4 mm.

Type: Cat. No. 15585, U. S. N. M.

Locality: Beverly, Massachusetts, June 2, 1876 (Burgess).

Specimens of this species are in collection from Tower City, North Dakota, (G. I. Reeves), Webster's No. 3122, 2 females; and Colorado, No. 1563, no collector's name, 1 female. I have named this species in honor of the late Edward Burgess, who collected the type specimen 37 years ago. I have seen one specimen in C. W. Johnson's collection from Lancaster, New York, which has the bristles on fore tibia indistinguishable.

Food-plant unknown.

50. *Agromyza plumiseta*, new species.

Female: Frons black, center stripe opaque, orbits, ocellar region, and the well defined ocellar triangle glossy black; breadth of frons one-third the head width, ocellar triangle reaching three-fourths of the way to lunule, which is whitish pollinose; orbital bristles four in number, moderately strong; hairs on orbits numerous and irregularly arranged, each orbit one-fourth the width of center stripe; the bristles situated close to inner margin; antennae of moderate size, deep black; third joint rounded in front, not as long as broad; second joint with distinct dorsal bristle; arista brown, swollen at base, pubescence very distinct, longer than basal diameter of arista, length of arista equal to from its base to upper orbital bristle; face black, concave, mouth margin slightly produced; cheek very short and low; marginal bristles rather well differentiated; proboscis yellow at apex; palpi black, slightly spatulate, and weakly bristled at tips; occiput not projecting. Mesonotum blue-black; two pairs of dorso-centrals present, setae numerous on disk, continued posteriorly beyond transverse line of posterior dorso-centrals; pleurae black, shining, with a bluish along the sutures, and below wing base brown; squamae yellowish with fringe concolorous; scutellum colored as disk of mesonotum, and pair of bristles very slightly smaller than basal pair. Abdomen black with a distinct, metallic blue sheen; basal segment brown; all segments with very numerous discal setulae, those on apices of segments most distinct; sixth segment very slightly elongated; base of ovipositor not longer than preceding segment. Legs black, shining, except posterior surface of mid tibia with the pair of bristles distinct. Wings clear; veins brownish yellow; first costal division barely more than one-third as long as second; inner cross vein at below end of first vein and at middle of discal cell; outer cross vein at very slightly beyond middle, and at more than its own length from inner; veins 2-3-4 gradually divergent on their last sections; last section of fifth vein about two-thirds as long as penultimate section. Halteres black.

Length 2 mm.

Type: Cat. No. 15586, U. S. N. M.

Locality: Bayamón, Porto Rico, January, 1899, (A. Busck). Along with the type there is a male from Fajardo, Porto Rico, February, 1899 (A. Busck), which belongs here. It differs only in having the frons slightly less than one-third the head width and though in poor condition is evidently, in other respects, identical with the female.

Food-plant unknown.

51. *Agromyza websteri*, new species.

Male and Female: Frons deep black; center stripe opaque, orbital and ocellar triangle glossy; width of frons almost one-half that of head, narrower at anterior margin than posteriorly; width of each orbit about one-fourth that of center stripe; five orbital bristles, generally present, but sometimes there are six in aberrant specimens; beside the bristles, which are situated on close to inner margin of orbit, there is an outer irregular row of short black hairs; antennae of moderate size, black with sometimes whitish pollinosity; second joint with distinct dorsal bristles, and weak apical hairs; third joint rounded, distinctly shorter than broad, pilosity very short, whitish; arista with a distinct, elongate thickening at base, which occupies almost one-third the length of arista; pubescence very indistinct; length of arista equal to from its base to middle of orbit; face opaque black; concave in middle, the mouth margin slightly produced; cheek opaque black; of almost equal height on its entire length, which is equal to about one-fourth the eye height; marginal bristles in a double row, the upper bristles upturned, of moderate length; vibrissa distinctly differentiated; ocelloids yellow-brown at apex; palpi black, slightly spatulate, weakly beveled. Mesonotum subshining black, with slight indications of grayish pollinosity, especially on sides; disk very thickly covered with short, upright, black setulae; three pairs of dorso-central pre-cut, the anterior pair weak, and occasionally there are 2-3 setulae in line with those, which are distinctly longer than the other dorsal setulae, but which are clearly not macrochaetae; no differentiated bristles between the posterior dorso-centrals; pleurae black, subshining, uterine brown in square brown, or gray, the margin blackish, fringe black-brown; scutellum concolorous with disk of mesonotum. Malorum, shining black; broadly ovate; segments with distinct dorsal setulae, three on anterior margins, and especially on sixth segment, in female, longer; sixth segment slightly elongated; base of ovipositor plate black; male hypopygium small, shining black. Legs black, shining, moderate length; no bristles distinguishable on mid tibia in any of the specimens before me. Wings grayish; veins brown-black; first costal division distinctly more than one-half as long as second; subcostal vein distinct; third with first at apex; inner cross vein below end of first vein; outer cross vein not upright, its upper extremity nearer to wing tip than its lower, situated at generally less than its own length from inner cross vein, and its upper extremity just before wing middle vein; 2+1 distally divergent at their apices; last section and penultimate section of fifth vein subequal. Halteres black.

Length 3.5-4 mm.

Type: Cat. No. 15587, U. S. N. M.

Locality: Seattle, Washington, issued January 21, 1913, from galls on twigs of pink wistaria from Japan, (P. M. Rhoder). Another specimen from same lot, in poor condition January

arista is comparatively shorter and more distinctly swollen in *schineri* than in *tilia*; and the posterior surface of mid tibia in *schineri* has no distinct bristles.

Length 2-2.5 mm.

Originally described from Europe.

Locality of specimens in U. S. National Museum collection, Toronto, Canada, (collection W. Brodie); I have seen two specimens reared from galls on Poplar by C. A. Frost, Framingham, Massachusetts, submitted by C. W. Johnson.

55. *Agromyza congregata*, new species.

Male: This species is very similar to *tilia*, but differs as follows: The orbital bristles are four in number, strong and equally spaced; the cheeks are comparatively higher, being at center rather more than one-third the height of eye; the marginal mouth bristles are strong and form a group at the anterior angle of cheek, amongst which the vibrissa is hardly distinguishable; the entire color of insect is a dark black; the legs are strong and there is no trace of the posterior bristles on the mid tibia; the wing venation is similar to *tilia*.

Length 1.75 mm.

Type: Cat. No. 15589, U. S. N. M.

Locality: Williams, Arizona, May, (H. S. Barber), male.

Food-plant unknown.

56. *Agromyza minima*, new species.

Male: Frons black, center stripe opaque, orbits and frons triangle glossy; breadth of frons one-third that of head; orbits narrow, each not one-fourth as wide as center stripe; four rather weak orbital bristles present, the orbits with additional short hairs; face black, opaque, concave in profile, mouth margin produced; cheek black, short, highest at center, where it is about one-fourth as high as the marginal bristles of moderate strength, the vibrissa weakly differentiated; occiput not projecting; antennae of moderate size; third joint regularly rounded, distinctly shorter than broad; arista not much swollen at base, tapering, almost bare, its length equal to from its base to the upper orbital bristle. Mesonotum glossy black, with a slight bluish tinge; two pairs of dorso-centrals present; pleurae concolorous with disk of mesonotum; squamae gray, margin and fringe brown. Abdomen glossy black, with a distinct metallic bluish tinge. Legs black, the posterior mid tibial bristles distinct, though small. Wings strongly inner cross vein at slightly beyond end of first vein, and at slightly beyond middle of discal cell; outer cross vein at about its own length from inner, and at slightly beyond wing middle; last section of first vein barely more than one-half as long as penultimate section; veins 3-4 almost parallel on their last section.

Length slightly over 1 mm.

Type: Cat. No. 15590, U. S. N. M.

Locality: Trinidad, West Indies, June, (A. Busck).

Paratypes: Three females. Those are identical with the male in all essential characters. Localities: Mayaguez, Porto Rico, January, 1899 (A. Busck); Utica, Mississippi, August (no other data); and one specimen taken on flowers of *Bignonia graveolans*, Mescalero, Mexico, October 2, 1896 (T. D. A. Cockerell). Food-plant unknown.

Williston's description of *Agromyza anthrax*.

Trans. Ent. Soc. Lond. 1896, p. 430.

"Agromyza anthrax, n. sp."

"Male: Black, but little shining. Front very broad, nearly square, its width rather exceeding its length; opaque black, on its lower margin yellowish. Antennae black, third joint rounded, large, pubescent, arista very short pubescent. Face receding, excavated, not at all visible from the sides; cheeks linear, with black bristles along the oral margin, and a rather stout vibrissal bristle in front. Palpi projecting beyond the oral margin, yellow. Mesonotum and scutellum a little shining. Abdomen opaque, oval. Halteres yellow. Knees and tarsi yellow, the distal joints of the latter brownish. Wings lightly tinged; the third vein terminates in the apex of the wing; penultimate section of fourth vein about one-third as long as the ultimate section of fifth."

"Length $1\frac{1}{2}$ mm."

"One specimen, St. Vincent."

Owing to the omission to mention the number of dorso-central bristles in this species, and some other essential characters, I cannot place this species in my synoptic table, but in general appearance it must approach very closely to *varifrons* Coquillett.

Williston's description of *Agromyza innominata*.

Trans. Ent. Soc. Lond. 1896, p. 443.

"Agromyza innominata, n. sp."

"Male: Head yellow, a blackish spot at the ocelli; front broad. Antennae yellow; third joint longer than broad; arista finely pubescent. Face short, gently excavated in profile; cheeks rather broad. Palpi moderate, dilated. Thorax obscurely reddish yellow; mesonotum with black hairs. Scutellum large, with two stout, remote, black bristles. Abdomen brown or blackish, yellowish at base. Legs light yellow; hind femora black at the immediate tip. Wings cinnereous; basal cells complete; penultimate section of fourth vein a little longer than the posterior."

"Length $1\frac{1}{4}$ mm."

"One specimen."

Locality: St. Vincent, West Indies."

I have not seen this species, and cannot place it in my synoptic table from the characters given in the description. No species of *Agromyza* that I have seen has only two scutellar bristles, and the palpi are remarkably large for a species of this genus. The head, with the exception of the palpi, as figured, looks like an *Agromyza*, but the arista is rather strongly pubescent, for most of the species in that genus. I suspect that it does not belong here, and the head figured on page 262 of Williston's Manual, which is quite evidently a reproduction of his figure 158 on Plate 14 of the original publication of the description, being given as "*Agromyza* (nov. gen.?)" in the Manual, would seem to indicate that Williston also thought so in 1903, whatever he may have thought in 1896. No indication is given as to the specific identity of the species, or source from which figure came in the Manual.

Lundbeck's description of *Agromyza arctica*.

Vidensk. Meddel. Copenhagen, 1899, p. 304.

"148. *A. arctica* n. sp. Fig. 4."

"*Brunneocinerea*, thorace opaco, abdomine subnitido, lateribus thoracis maculis flavis ornatis, lateribus abdominis flavis, segmentis abdominis margine posteriore anguste flavescente. Fronte sordide flava, lunula supra antennis flava; antennis flavis, basi et margine exteriori articuli tertii brunnescentibus, arista nigra. Epistoma flavo. Alis hyalinis, leviter flavescentibus, nervo longitudinali quarto in apice alae excurrente, costa ad apicem nervi longitudinali quarti producta. Halteribus flavis. Pedibus cinerascens, geniculis lateribus inferioribus femorum flavis. ♂ ♀. Long. 2 mm.

"*A. geniculatæ* affinis. Mas. Brunneocinereus, thorax opaco, abdomen subnitidum, thorax longe sed parce pilosus, abdomen leviter pilosum, scutellum in margine posteriore quattuor setis longis instructum; latera thoracis dilute cinerea, maculis flavis ornata, latera abdominis tota flava, margines posteriores segmentorum anguste flavescentes (saepe obsolete), metanotum sub scutellum linea flava ornatum. Frons sordide flava, supra antennis lunula flava. Antennae flavae, basi et margine dorsali articuli tertii brunnescentibus, arista nigra. Epistoma flavum, occiput brunneogriseum. Alae hyalinae, leviter flavescentes, nervus longitudinalis secundus et tertius leviter arcuati ad apicem reflexi, nervus longitudinalis quartus rectus, in apice alae excurrente, costa ad apicem nervi longitudinali quarti producta, nervus transversali appropinquati, posterior ante mediam alam situs. Halteres flavi. Pedes cinerei, geniculis et femorum lateribus inferioribus flavis sive refuscentibus. Fem. Mari similis, abdomen ovipositorum conico, nigrobrunneo, valde nitido, daubus lamellis nigris, parvis terminato."

"Individua plures adsunt colore toto et praesertim abdominis
multo versimiliter immatura."

"Synes at forekomme temmelig almindelig langs hele Vestkysten
fra mindste op til 69° N. Br.; træffes især i Pilekrattet, Larven lever
ogsaa i Pileblade. Igalliko-Fjord, Tunugdliarfikfjord, Tassiusak
Køstianshaab, Sydostbugten (Forf.).

This species bears a resemblance to *borcalis* described on a
previous page, the venation being almost identical in Lund-
beck's figure with that given in this paper for *borcalis*, but his
description is lacking in several essentials, so that it is not
possible to say definitely whether the species are really the
same or not.

Cerodontha Rondani.

Syn: *Cerodontha Rondani*, Dipt. Ital. prod. Vol. IV, 1861, p. 10.
Odontocera Macquart, Suit a Buffon, Vol. II, 1835, p. 615 (Proce.).
Ceralomyza Schiner, Wien. entom. Monatschr. Vol. VI, 1862, p. 434.

Characters of the Genus.

Similar in most respects to *Agromyza*, but the third antennal
joint terminates, on the upper surface, in a thorn-like point.
The frontal and thoracic bristling is similar in nature to that
of *Agromyza*, but in no case have I seen more than two scutellar
bristles on the species I have examined; nor do I know of any
species in which more than two are present. The mid tibia
has no posterior bristles, and the costa always reaches to the
fourth vein.

Cerodontha dorsalis Loew.

Plate XXXI, Figs. 33, 39.

Syn: *Odontocera dorsalis* Loew, Dipt. Amer. Sept., Indig., Cent. I 1861,
species 99.

Male and Female: Frons yellow, opaque, in breadth about one-
half that of head; orbits sometimes blackened, very narrow, on upper
half each not over one-sixth as wide as center stripe; three distinct
orbital bristles present, and on lower portions a few short hairs; prodi-
sternal ocellar bristles parallel, or slightly divergent, separated at base
by as wide a space as posterior ocelli; antennae yellow, third joint
black, one and one-half times as long as broad, ending in a thorn-
like point on upper side; arista black, distinctly thickened at base and
flaring to near its middle, pubescence indistinguishable, length of
arista short of twice the length of antennae; face yellow, slightly concave,
central keel rounded; cheeks yellow, higher posteriorly than anteriorly,
and at highest point about one-half as high as eye, marginal bristles
distinct; vibrissa strong, differentiated from marginal bristles; proboscis
and palpi yellow; occiput unprojecting on upper half. Mesonotum
and disk entirely glossy black, with sometimes an indication of grayish

pollen, or with the central portion in front of scutellum yellow, more rarely with two narrow black stripes on sides, and the central yellow portion carried forward at its anterior margin, slightly beyond middle as narrow lines which more or less distinctly intersect the broad disk; black mark, giving the disk the appearance of having five stripes, or a pattern somewhat similar to that of *Agromyza melampyga*; lateral margins of mesonotum broadly yellow; humeri with a black spot; four pairs of dorso-central bristles on mesonotum; no setulae on disk; pleurae yellow with black variegations; squamae yellow, the fringe brownish or grayish; scutellum all black or with the disk yellow, two scutellar bristles present. Abdomen from almost entirely yellow to almost entirely black, posterior margins of segments narrowly yellow. Legs slender, yellow, sometimes with fore tibiae and tarsi blackened, all tarsi brownish. Wings as figure.

Length 2-2.5 mm.

The following is a list of the States from which I have seen specimens: Connecticut, Massachusetts, Iowa, Florida, Georgia, District of Columbia, Kentucky, Indiana, Nevada, New Mexico, Texas, Utah, Washington, Tennessee, Nebraska, Michigan, Illinois and California.

I have also seen specimens from Mexico and Porto Rico. The larva mines the stems of grains and grasses.

ADDENDA.

Agromyza quadrisetosa, new species.

Female: Back subshining. Head yellow, ocellar spot, upper third of orbits, back of head, 3rd antennal joint, palpi and upper mouth margin black. Mesonotum with lateral margins broadly pale, whitish yellow, humeri with a black spot; pleurae with upper margin concolorous with margin of mesonotum; scutellum yellow, margined on sides with black, squamae yellow. Abdomen black, glossy, the segments with narrow, yellow, posterior margins. Legs entirely shining black. Wings clear, basal portion of veins pale yellow, outer portions brownish. Halteres yellow.

Frons about one and one-third times as long as broad at vertex; orbits glossy, six orbital bristles present, incurved, situated on middle of orbit and of good length; orbits otherwise bare; antennae of moderate size, third joint rounded, second joint with dorsal bristle distinct; arista tapering, bare, brown in color, equal in length to from its base to second uppermost orbital bristle; cheeks at anterior margin about equal in height to breadth of third antennal joint, at posterior margin equal to slightly more than half of the height of the eye. Mesonotum with 4 pairs of dorso-centrals, between which are 2-3 irregular rows of setulae which do not extend to posterior dorso-centrals; scutellar bristles (4) subequal. Abdomen with apices of all segments armed with rather strong bristle-like hairs. Legs with mid tibial posterior bristles absent or very weak. Wings with costa to fourth vein; veins 4-1

emergent; outer cross vein at less than its own length from inner and the little beyond end of first vein; last section of fifth vein twice as long as penultimate section.

Length 2 mm.

Type: Cat. No. 15957, U. S. N. M.

Type locality: San Antonio, Texas, April 8, 1907—F. C. Pratt. Nothing recorded of early stages.

This species belongs to the *pusilla* group, but may readily be separated from any of those in this paper by the black palpi, third antennal joint and legs. It is distinct from any of the European species I have examined.

Agromyza melampyga Loew.

This species has been bred by C. R. Jones at San Antonio, Texas, from root of *Plantago media*.

Agromyza citreifrons Malloch.

I had some doubt as to the distinction of this species from *Hilarella* Zetterstedt, but I have since examined specimens belonging to the National Museum in Budapest, and consider them quite distinct. *Hilarella* has the frons darker than *citreifrons*, the antennæ darkened on upper surface of third joint, the face less receding, the eyes longer than high, the wings narrower, the inner cross vein distinctly before middle of discal cell, and the last section of fifth vein very distinctly longer than the penultimate section.

Agromyza longipennis Loew.

I have examined specimens from Europe, of *geniculata* since writing the above, and find they are distinct from *longipennis* in having the legs less broadly yellow on joints, the arista almost bare, as against the distinct pubescence of *longipennis*, and the last section of fifth vein distinctly shorter than penultimate section.

Agromyza angulata Loew.

Two specimens submitted as *luctuosa* Meigen from Budapest represent two distinct species, one of which is very close to *angulata* Loew. Under the circumstances I consider that it is not desirable to question the retention of *angulata* as the name for the American species.

Agromyza abnormalis Malloch.

This species differs from *obscuritarsis* Rondani in being more robust, darker in color throughout, and particularly in that the frons and halteres, and in neuration, the last section of fifth vein in *obscuritarsis* being about one and one-half times as long as penultimate section. Both species have 4 pairs of dorso-centrals.

Agromyza kincaidi Malloch.

On comparison of the type of this species with specimens submitted from Budapest museum as *nigripes*, I find that the European form has over all a more glossy black color, the frons is much narrower, being barely wider than width of either eye, and narrowed anteriorly, the arista is almost bare, the squamae are darker, with brown fringes, and the last section of fifth vein is almost as long as the penultimate section.

An example from Hampton, N. H. (S. A. Shaw) agrees in almost every particular with those from Europe so that this species may be added to the American list and the name changed to *subnigripes* n. nom. for the reasons stated in this paper.

Agromyza pruinosa Coquillett.

This species has been reared from larvae mining under bark on birch trees by C. T. Green of the Division of Forest Insects, at Falls Church, Va. I have examined two males which agree in every particular with the type, except in being rather larger.

Agromyza caerulea Malloch.

I have examined a series of 8 specimens reared from *Ipomoea sinuata* and 5 from *Ipomoea lacunosa*, at Victoria, Texas, in September, 1907, and 7 from same locality August, 1907, labelled *Ipomoea*, by J. D. Mitchell. They agree with the Mexican specimen in all particulars.

Agromyza texana Malloch.

Two pairs taken in copula at Kerrville, Texas. June 19, 1907 (F. C. Pratt).

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Names in italics are synonyms.

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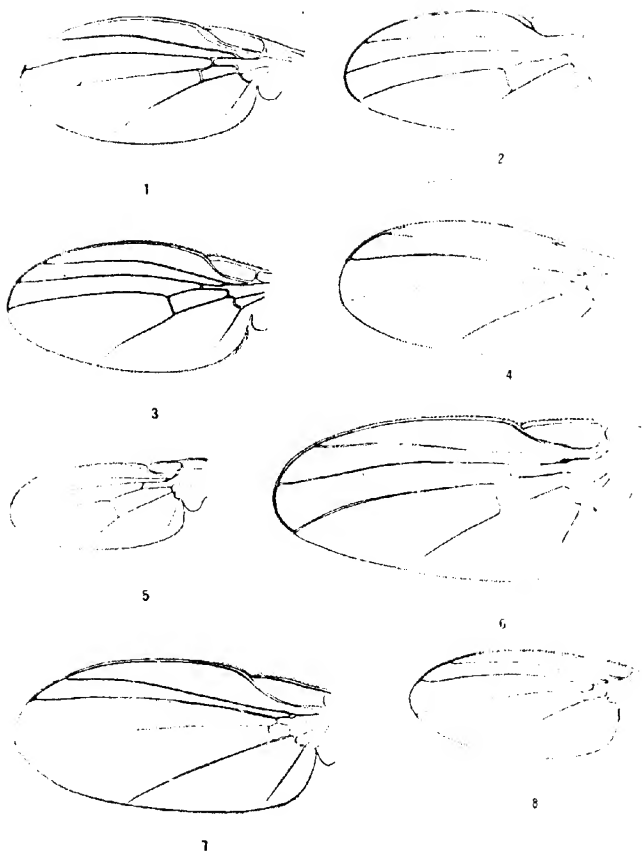
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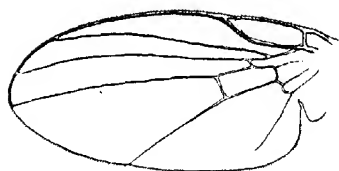
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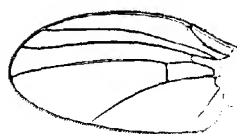
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The Plates were drawn by W. R. Walton, with the exception of Figures 14, 15, 30, 34, and 38, which are by the author.





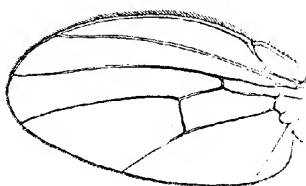
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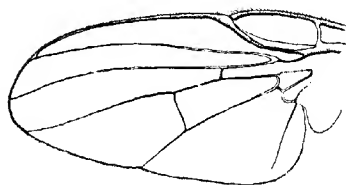
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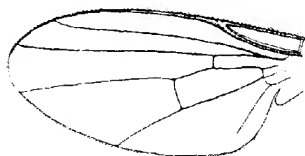
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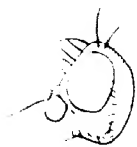
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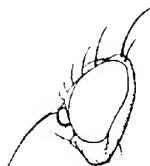
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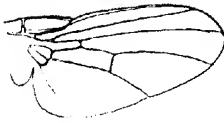
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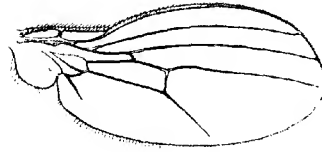
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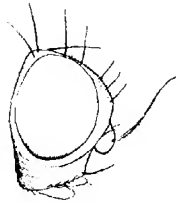
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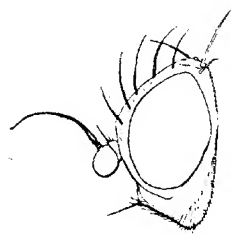
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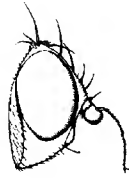
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THE WING VENATION OF THE FULGORIDÆ.

Z. P. MEEHLE.

The present paper is a continuation of my work on the homologies of the wing veins of Homopterous insects; a paper having previously been published on the wing venation of the Jassidæ.*

The present paper is based upon a study of the wing pads of eleven genera of Fulgoridæ. These eleven genera are distributed among seven of the eleven commonly recognized sub-families of Fulgoridæ. Two of the sub-families not represented in this study are not found in our territory and I have not been able to secure representatives of the two remaining sub-families, *Achilida* and *Fulgorida*. The venation of these two sub-families presents no special difficulties when viewed in the light of our knowledge of other Fulgoridæ which have been carefully studied.

The same technique has been used in preparing the material for studying the wing venation of the Fulgoridæ that was used for studying the Jassidæ. The nymphal wings being removed as carefully as possible were mounted in water. The wing pad was then either drawn with the aid of a camera lucida or a photomicrograph made. Afterward a pen and ink drawing was made from the photomicrograph uniform with the camera lucida drawings. The drawings of the adult wings were made from balsam mounts with the aid of the Edinger drawing apparatus. The magnifications used in both cases varied greatly being adapted as far as possible to the needs of individual cases.

The relation of the main tracheæ of the wing pads to the body tracheæ is an interesting one and one upon which much stress has been laid in the past. The relationships of the main tracheæ of the wing pads can be much better understood if they can be traced back to their origin from the main body tracheæ.

Unfortunately, however, the wing pads of most insects are so placed that the body tracheæ lie very deep. This makes it practically impossible to secure the body tracheæ by the

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ordinary methods of dissection. If the wing is carefully removed, however, the relationships of the main tracheæ need not be disturbed. Some emphasis has also been placed on the fact that in some families the tracheæ of the wing pads arise from a single basal trachea, whereas in certain other families the radio-medial group of tracheæ arises from a cephalic body trachea while the cubito-anal group arises from a caudal body trachea. In certain cases this character has been used to indicate that one family is more primitive structurally than another. That such a position is untenable is clearly shown in at least two genera of the Fulgoridæ in which I was so fortunate as to secure enough of the body tracheæ as to determine this point. In *Thionia* (Figs. 27, 28) the tracheæ of the fore wing pad arise from a single body trachea while the tracheæ of the hind wing pad arise from a cephalic and a caudal body trachea. In *Amphiscepa* (Figs. 5, 6), on the other hand, the tracheæ of the fore wing arise from two body tracheæ whereas the tracheæ of the hind wing arise from a single body trachea.

THE FORE WING.

Unlike the fore wings of the Jassidæ, the fore wings of the Fulgoridæ are exceedingly variable. As is well known, the adults of many Fulgoridæ occur in two forms, a long-winged or *macropterous form*, and a short-winged or *brachypterous form*. This is especially true of certain genera. While the problem of the origin and significance of this variation is an exceedingly interesting one, it has not been taken into consideration in this paper, and as a rule, only *macropterous forms* have been considered with the exception of a few cases where the *brachypterous forms* are the usual ones.

The wings of the Fulgoridæ show two marked forms of specialization from the hypothetical type, the one by the addition of accessory branches to the main veins and the other by the reduction of the number of branches of the main veins. The one may be known as specialization by addition, and the other as specialization by reduction. An almost perfect series can be traced from the one extreme to the other. Forms like *Ormenis* (Fig. 13), show as great specialization by addition as is found in any insect of any order, while forms like *Bruchomorpha* (Fig. 33), show a great deal of specialization by re-

ation. While the wing venation of most of the insects that have been studied extensively so far can be reduced to a more or less uniform type for the family, in the Fulgoridae no such typical form can be given. In the following discussion of the individual tracheæ the differences in the characters of the same trachea in different genera will not be emphasized so much as their resemblances.

The Costa of the Fore Wing.

The costa of the fore wing is usually present in the Fulgoridae, in fact it was found in practically every genus studied. Typically, costa is a single unbranched trachea usually of somewhat less extent than subcosta. In *Ormenis* (Fig. 3), however, there are many small lateral tracheæ formed along the entire length of the costal trachea, and in *Amphiscepa* (Fig. 5), the tip of the costal trachea breaks up into several smaller tracheæ. In *Thionia* (Fig. 27), the costal trachea shows a strong lateral branch near its base. This branch runs parallel with the main branch of costa and seems to be included in the same forming vein.

The Subcosta of the Fore Wing.

The subcosta has been found present in all of the genera studied. In many of the genera subcosta is a larger and more important trachea than radius. In nearly all cases it lies parallel with radius for the greater part of its length, while in *Scolops* (Fig. 23), it lies parallel with radius for its entire length. Subcosta is typically two branched in the *Delphacida* (Figs. 43, 45), and in the *Cixiida* (Fig. 47), while in *Amphiscepa* (Fig. 5), and *Ormenis* (Fig. 3), the tip of the subcosta breaks up into several small tracheæ.

The Radius of the Fore Wing.

Radius in the Fulgoridae occupies a much less important position than in the wings of most other insects which have been studied in detail up to the present time. In most cases the radial trachea lies parallel with the subcostal trachea and usually only a single vein is formed in the region occupied by these two tracheæ. In *Stobcera* (Fig. 45), radius is a single unbranched trachea lying parallel with subcosta for more than half of its length then diverging and running parallel with one of the branches of medius for a short distance it

diverges toward the costal border. Radius occupies a somewhat similar position in *Myndus* (Fig. 47), except that there are three or four small branches near the tip and the trachea does not coalesce with medius in any part of its course. The condition of the radial trachea in *Dictyophara* (Fig. 25) is almost identical with that in *Myndus*, except that there are small lateral branches toward the tip. In *Thionia* (Fig. 27) and *Scolops* (Fig. 23), the radial trachea is quite similar in appearance to that in the genera discussed above except that separate veins are formed along these two trachea in *Thionia*. In both of these genera the lateral branches near the tip are much weaker and more uncertain in their position and are not the fore-runners of typical and fairly constant longitudinal veins, but of rather uncertain cross veins which are fairly common in these genera. In *Amphiscepa* (Fig. 5), and *Acanalonia* (Fig. 1) radius is a single unbranched trachea. In *Ormenis* (Fig. 3), the radial trachea consists of two main trachea which separate into several smaller branches before reaching the tip.

The Medius of the Fore Wing.

In all the genera studied the medial trachea is the most important trachea of the fore wing and its branches occupy more area than the branches of any other trachea. In the genera studied medius seems to be typically four branched only in *Amphiscepa* (Fig. 5). Each one of these branches, however, branches one or more times before reaching the tip of the wing. In *Ormenis* (Fig. 3), medius divides into two branches each branch again dividing into two branches. Each of these branches, however, is several times divided before reaching the tip of the wing pad. In *Acanalonia* (Fig. 1), medius is three branched, these branches representing medius one, medius two and medius three plus four. In *Scolops* (Fig. 23), *Dictyophara* (Fig. 25) and *Thionia* (Fig. 27), medius is typically two branched, although these branches may divide one or more times before reaching the tip of the wing pad. The veins which form along these secondary branches are not at all constant in position and relative importance. In *Stobaria* (Fig. 45), medius divides into two main branches. These branches represent medius one plus two and medius three plus four, medius one and medius two separating before reach-

ing the tip of the wing pad. In *Myndus* (Fig. 47), medius is typically four branched with an accessory branch between medius one and medius two.

The Cubitus and the First Anal of the Fore Wing.

As in the Jassidae the cubital-first anal group forms the most characteristic land-mark in the tracheation of the Fulgoridae. These two trachea are united for a short distance from the body trachea and cubitus is usually two branched. In *Thionia* (Fig. 27), *Dictyophara* (Fig. 25) and *Acanalonia* (Fig. 1), cubitus is unbranched, while in *Phylloscelis* (Fig. 7), cubitus is two branched and in *Stobocera* (Fig. 45), there is an accessory branch between cubitus one and cubitus two.

The Second and Third Anal of the Fore Wing.

The second anal trachea is a simple unbranched trachea and usually lies parallel with the first anal trachea. The third anal trachea is nearly always present in Fulgoridae and is usually two branched. The second branch when present usually forms the anal border of the fore wing.

THE HIND WING.

The hind wing of the Fulgoridae is almost as variable as the fore wing, very little similarity being observed in the different genera of some of the sub-families. Quite a little variation is frequently observed in different individuals of the same species.

The Costa of the Hind Wing.

The costal trachea is present in the following widely separated genera: *Myndus* (Fig. 48), *Scolops* (Fig. 24), *Dictyophara* (Fig. 26), *Thionia* (Fig. 28), *Acanalonia* (Fig. 2), and *Phylloscelis* (Fig. 8). In *Thionia*, *Phylloscelis* and *Myndus* it is united with subcosta for some distance from the body trachea. In *Scolops* it is present only as a weak trachea at the base of the wing.

The Subcosta of the Hind Wing.

The subcostal trachea was found in all the wing pads studied. In most of the genera it runs parallel with radius for almost its entire length and diverges at the tip. The radial and subcostal tracheae are included in a common vein

except at the tip where subcosta diverges and the vein which forms along this tip in the adult resembles a branch of the radial vein. This condition is especially apparent in *Stobæra* (Fig. 46), *Myndus* (Fig. 48), *Dictyophara* (Fig. 26) and *Amphisceps* (Fig. 6). In *Scolops* (Fig. 24), subcosta appears merely as a weak trachea lying parallel with radius along its base.

The Radius of the Hind Wing.

In nearly all cases radius of the hind wing is a single unbranched trachea. In certain genera, however, such as *Scolops* (Fig. 24), *Dictyophara* (Fig. 26) and *Acanalonia* (Fig. 2), radius shows more or less tendency to branch near the tip. These branches are rather variable as an examination of different individuals of the same species clearly shows. Therefore I have made no attempt to homologize these branches.

The Medius of the Hind Wing.

A typical medius of the hind wing of Fulgoridæ is two branched, but frequently these branches show a decided tendency to branch again before reaching the tip of the wing pad. In *Stobæra* (Fig. 46) and *Thionia* (Fig. 28) medius is a simple unbranched trachea which in *Stobæra* runs parallel with cubitus for a considerable distance, the veins of the adult coalescing at this point.

The Cubitus of the Hind Wing.

In many genera cubitus of the hind wing occupies the greatest area and bears somewhat the same relationship to the other tracheæ of the hind wing that medius bears to the other tracheæ of the fore wing. In *Myndus* (Fig. 48) and *Phyllostalis* (Fig. 8), cubitus is unbranched. In *Stobæra* (Fig. 46), *Thionia* (Fig. 28) and *Scolops* (Fig. 24) cubitus is typical. In the other genera studied cubitus has two principal branches, each of which bears one or more accessory branches.

The Anals of the Hind Wing.

The first anal of the hind wing bears the same relation to cubitus that it does in the fore wing. The second anal trachea is usually simple and unbranched, and lies parallel with the first anal. The third anal trachea has been found in all of the genera studied and is usually branched. Although in some cases *Thionia*, *Dictyophara* and *Scolops* the third anal trachea is three branched.

SUMMARY.

Owing to the fact that the adult wings of the Fulgoridae vary so much it has seemed best to summarize the homologues of adult wing veins by giving a discussion of the characters of the adult wings of the various subfamilies.

Sub-family **Fulgorida.**

Both the fore and hind wings of this sub-family are characterized by a large amount of reticulation. Nearly all the members of this sub-family are characterized by having a large number of accessory veins. These accessory veins may be added to radius, medius or cubitus, but in some cases, as in *Poiocera* (Fig. 9) all three of these veins bear accessory veins. In the hind wing radius and medius do not usually bear many accessory veins, but cubitus usually has several accessory veins. Another characteristic of the hind wings is the fact that the cross veins are apt to be connected together forming false veins between the principal veins. These false veins usually lie along the folds of the wing.

Sub-family **Flatida.**

The chief characteristics of this sub-family are: First, that the costal vein is remote from the costal border of the wing and connected with it by means of a number of cross veins; second, that radius and medius are provided with a large number of accessory veins; and third, that these accessory veins are usually connected by a definite series of cross veins at a uniform distance from the apical border of the wing. The hind wing is chiefly characterized by the great development of the anal area of the wing, and by a large number of accessory veins attached to cubitus.

Sub-family **Acanaloniida.**

The fore wings of the members of this sub-family are characterized by having a large number of cross veins between the branches of the principal veins. They are also characterized by having radius simple and unbranched, and the larger area of the wing occupied by the branches of the medius. In some cases, *Amphiscepa* (Fig. 15), medius is typically four branched with the addition of accessory veins to some of the branches. In other cases, *Acanalonia* (Fig. 17), medius is three branched,

the branches representing medius one, medius two and medius three plus four. The hind wing is characterized by the great development of cubitus, and the fact that in certain cases, *Amphiscepa* (Fig. 16), radius and medius coalesce for a considerable distance from the base of the wing.

Sub-family **Achilida.**

The fore wings in this sub-family are characterized by the fact that subcosta and radius are coalesced for a considerable distance from the base, and the fact that there are usually several cross veins between subcosta and the costal border of the wing. Radius and medius offer no special characters and cubitus is typically two branched, although there are frequently accessory cross veins between cubitus two and the anal border of the wing.

Sub-family **Dictyopharida.**

The chief characteristics of this sub-family are to be found in the complete or all but complete coalescence of subcosta and radius. In *Scolops* (Fig. 29), they are completely coalesced. In *Dictyophara* (Fig. 31), nearly completely coalesced, but in *Phylloscelis* (Fig. 22), are not coalesced except for a short distance at the base. Medius is typically two branched, but in *Scolops* (Fig. 29), there are several accessory branches. In *Scolops* (Fig. 29), and *Dictyophara* (Fig. 31), cubitus is typically two branched, but in *Phylloscelis* (Fig. 22), cubitus bears several accessory branches.

Sub-family **Issida.**

I have studied only a few genera in this sub-family. In *Thionia* (Fig. 35), all of the branches of the principal veins are reduced, medius alone being typically two branched. All of the veins are connected by a number of cross veins. In *Bruchomorpha* (Fig. 33), a study of the adult wing alone seems to indicate a condition closely approximating the condition found in the Delphacida, in which radius and medius are coalesced for a considerable distance, radius diverging strongly and coalescing with medius throughout the middle of its course, and then diverging strongly toward the costal border of the wing. In all of the Issida that I have examined second and third anal are coalesced for nearly half of their course at

the tip. In *Thionia* (Fig. 36), the anal area of the hind wing is larger than the preanal area, and third anal is characterized by the addition of a large number of accessory veins. In *Brachomorpha* (Fig. 34), the hind wing is greatly reduced in area, and the principal veins only are represented by simple unbranched veins.

Sub-family **Derbida.**

In this sub-family, also, subcosta and radius are coalesced for a considerable distance from the base, and both are typically two branched; although in some cases, *Otiocerus* (Fig. 39), there are a number of cross veins between subcosta and the costal border. Medius is typically four branched with a number of accessory veins added to medius one. In *Anotia* (Fig. 37), and *Otiocerus* (Fig. 39), there is an accessory vein between medius three and four. In *Lamenia* (Fig. 41), there are no accessory veins between medius three and medius four, and only a single accessory vein between medius one and medius two. Cubitus is typically two branched, but in *Otiocerus* and *Anotia* these branches do not extend to the anal border of the wing, but unite with the coalesced anals at some little distance from the border of the wing. In the hind wings, subcosta and radius are coalesced, and medius is two branched in *Anotia* (Fig. 38) and *Otiocerus* (Fig. 40), but unbranched in *Lamenia* (Fig. 42). Cubitus of the hind wing is two branched in all of the members of this sub-family which I have examined.

Sub-family **Cixiida.**

This sub-family also is characterized by the fact that subcosta and radius are coalesced for some distance from the base. Subcosta is typically two branched, although in *Bothrocera* (Fig. 60), *Oliarus* (Fig. 58) and *Cixius* (Fig. 62) superfluous veins are added between subcosta one and subcosta two. Radius is typically three branched, although the branches are somewhat variable in their relationships. Medius is typically four branched with an accessory vein between medius one and medius two, although in *Oliarus* (Fig. 58), both medius one and medius two bear accessory veins. Cubitus of the fore wing is typically two branched, and second and third anals are coalesced at the tip. In the hind wing subcosta and radius are coalesced for a considerable distance from the base.

and radius has two branches except in *Myndus* (Fig. 50). Medius is typically three branched except in *Ædeus* (Fig. 63), where it is only two branched. Cubitus is unbranched in *Myndus*, and two branched in all of the other members of this subfamily that I have examined.

Sub-family **Delphacida.**

In the fore wing, subcosta is typically two branched. Radius is coalesced with subcosta for about half of its length, when it diverges suddenly, then coalesces near the middle of its course with medius one plus two. It then diverges toward the costal border of the wing. Medius is typically three branched, the branches represented being medius one, medius two and medius three plus four. Medius three plus four frequently coalesces for a short distance with cubitus one, as in *Liburnia* (Fig. 53) and *Stenocranus* (Fig. 49). In *Stobara* (Fig. 51), these two veins are connected by a short cross vein. Cubitus is three branched an accessory vein being developed along the anal side of cubitus one. In the hind wing, subcosta and radius are coalesced for more than half of their length and medius is unbranched. Cubitus is typically two branched, cubitus one coalescing for almost its entire length with medius, being separated only at its tip. The anal area of the hind wing is considerably enlarged and the third anal is frequently three branched.

ACKNOWLEDGEMENTS.

The writer wishes to express his appreciation for the kindly advice of Professor Herbert Osborn, and for the helpful criticisms of C. L. Metcalf, who furnished, also, the specimens of *Myndus radialis*, Osb., the only species of the subfamily *Cixiina* available for study. C. S. Brimley and Rev. A. H. Mann have furnished some material, but Luella Correll Metcalf has collected most of the material which was used as a basis for this paper.

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EXPLANATION OF PLATES.

PLATE XXXII.

- Fig. 1. Fore wing pad of *Acanalonia* sp.
- Fig. 2. Hind " " *Acanalonia* sp.
- Fig. 3. Fore " " *Ormenis septentrionalis* Spin.
- Fig. 4. Hind " " *Ormenis septentrionalis* Spin.
- Fig. 5. Fore " " *Amphiscepa bivittata* Say.
- Fig. 6. Hind " " *Amphiscepa bivittata* Say.
- Fig. 7. Fore " " *Phylloscelis atra* Germ.
- Fig. 8. Hind " " *Phylloscelis atra* Germ.

PLATE XXXIII.

- Fig. 9. Fore wing of *Poilocera fuliginosa* Uhl.
- Fig. 10. Hind " " *Poilocera fuliginosa* Uhl.
- Fig. 11. Fore " *Cyrtoptus belliragei* Stål.
- Fig. 12. Hind " *Cyrtoptus belliragei* Stål.
- Fig. 13. Fore " *Ormenis septentrionalis* Spin.
- Fig. 14. Hind " *Ormenis septentrionalis* Spin.
- Fig. 15. Fore " *Amphiscepa bivittata* Say.
- Fig. 16. Hind " *Amphiscepa bivittata* Say.
- Fig. 17. Fore " *Acanalonia latifrons* Walk.
- Fig. 18. Fore " *Elidiptera opaca* Say.
- Fig. 19. Hind " *Elidiptera opaca* Say.
- Fig. 20. Fore " *Catonia* sp.
- Fig. 21. Hind " *Catonia* sp.
- Fig. 22. Fore " *Phylloscelis atra* Germ.

PLATE XXXIV.

- Fig. 23. Fore wing pad of *Scolops* sp.
 Fig. 24. Hind " " *Scolops* sp.
 Fig. 25. Fore " " *Dictyophara* sp.
 Fig. 26. Hind " " *Dictyophara* sp.
 Fig. 27. Fore " " *Thionia simplex* Germ.
 Fig. 28. Hind " " *Thionia simplex* Germ.

PLATE XXXV.

- Fig. 29. Fore wing of *Scolops perdx* Uhl.
 Fig. 30. Hind " *Scolops perdx* Uhl.
 Fig. 31. Fore " *Dictyophara florens* Stal.
 Fig. 32. Hind " *Dictyophara florens* Stal.
 Fig. 33. Fore " *Bruchomorpha oculata* Newm.
 Fig. 34. Hind " *Bruchomorpha oculata* Newm.
 Fig. 35. Fore " *Thionia bullata* Say.
 Fig. 36. Hind " *Thionia bullata* Say.
 Fig. 37. Fore " *Anotia* sp.
 Fig. 38. Hind " *Anotia* sp.
 Fig. 39. Fore " *Otiocerus coquebertii* Kirby.
 Fig. 40. Hind " *Otiocerus coquebertii* Kirby.
 Fig. 41. Fore " *Lamenia vulgaris* Fitch.
 Fig. 42. Hind " *Lamenia vulgaris* Fitch.

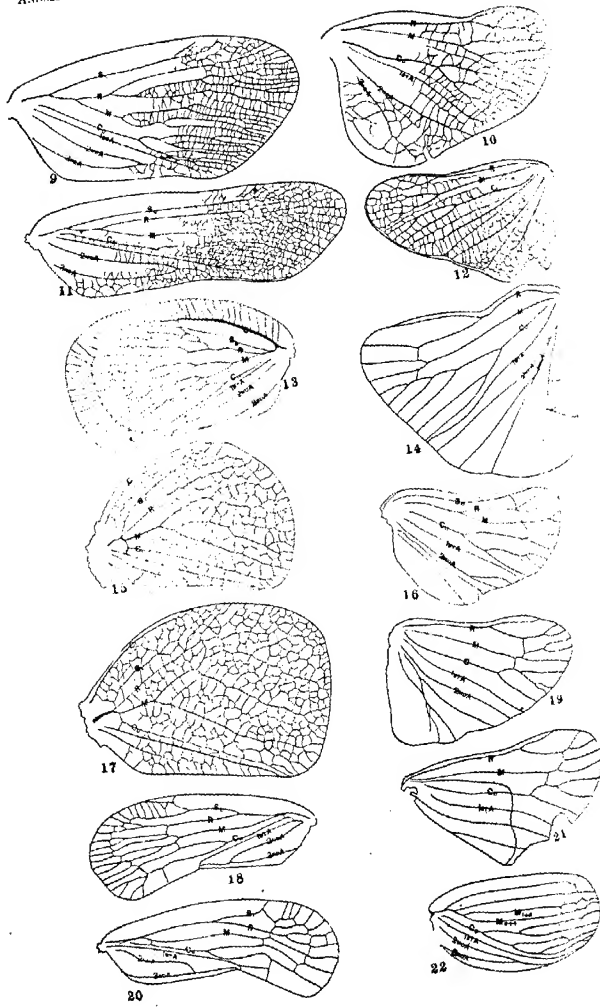
PLATE XXXVI.

- Fig. 43. Fore wing pad of *Stenocranus* sp.
 Fig. 44. Hind " " *Stenocranus* sp.
 Fig. 45. Fore " " *Stobaera tricarinata* Say.
 Fig. 46. Hind " " *Stobaera tricarinata* Say.
 Fig. 47. Fore " " *Myndus radialis* Osb.
 Fig. 48. Hind " " *Myndus radialis* Osb.

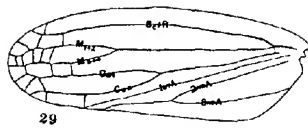
PLATE XXXVII.

- Fig. 49. Fore wing of *Stenocranus lautus* V. D.
 Fig. 50. Hind " *Stenocranus lautus* V. D.
 Fig. 51. Fore " *Stobaera tricarinata* Say.
 Fig. 52. Hind " *Stobaera tricarinata* Say.
 Fig. 53. Fore " *Liburnia ornata* Stal.
 Fig. 54. Hind " *Liburnia ornata* Stal.
 Fig. 55. Fore " *Myndus* sp.
 Fig. 56. Hind " *Myndus* sp.
 Fig. 57. Fore " *Cixius* sp.
 Fig. 58. Fore " *Oliarus 5-lineatus* Say.
 Fig. 59. Hind " *Oliarus 5-lineatus* Say.
 Fig. 60. Fore " *Bothriocera pro-signoretii*.
 Fig. 61. Hind " *Bothriocera pro-signoretii*.
 Fig. 62. Fore " *Cæleus decens* Stal.
 Fig. 63. Hind " *Cæleus decens* Stal.

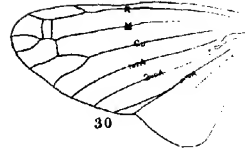




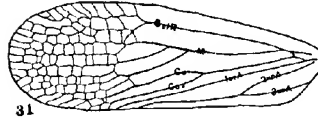




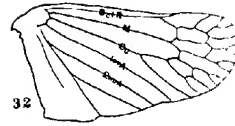
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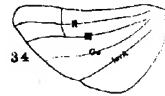
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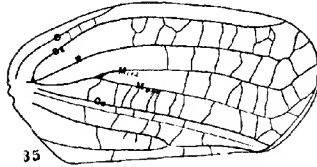
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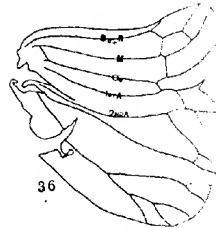
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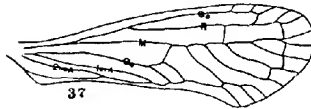
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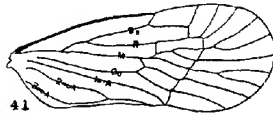
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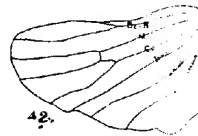
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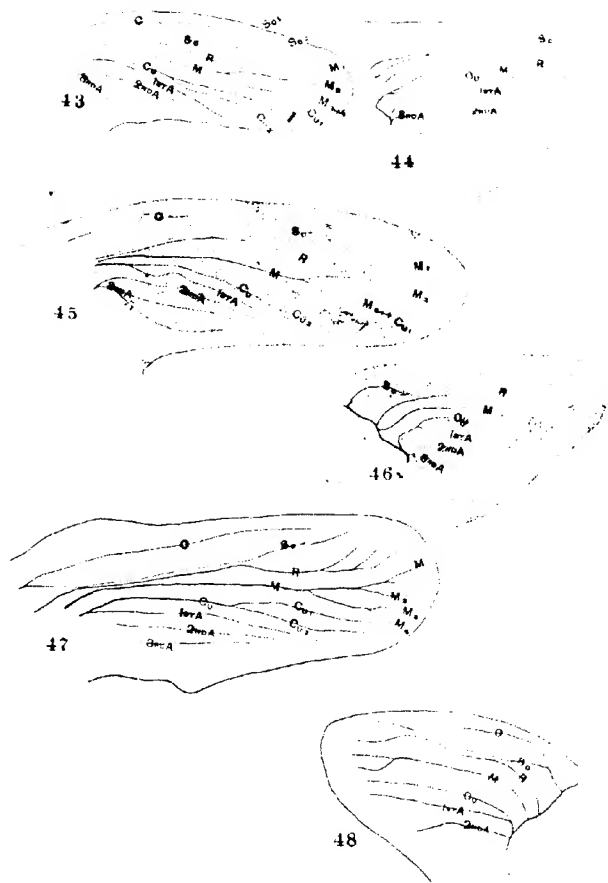
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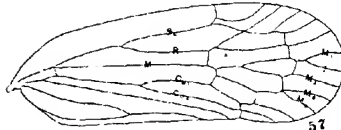
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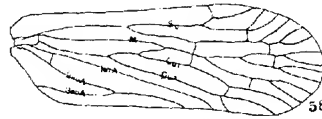
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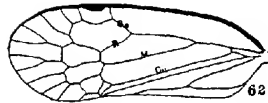
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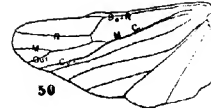
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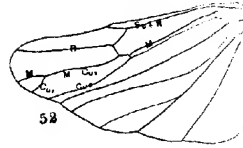
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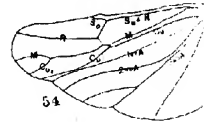
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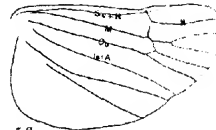
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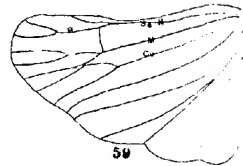
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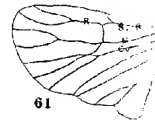
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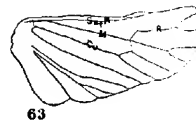
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THE PRINCETON COLLECTION OF FOSSIL BEETLES FROM FLORISSANT.

By H. F. WICKHAM, Iowa City, Iowa.

Through the kindness of Professor Gilbert van Ingen, of the Department of Geology of Princeton University, I have been allowed to study the collection of Florissant fossil beetles in his care. The series is of particular interest since it forms a part of the material used by Scudder in working up two of his principal papers on the Tertiary insects* and contains many of his types and cotypes. He studied the present collection with special reference to the Adephaga, Chalcidomorpha and Rhynchophora and in these groups described practically all of the novelties which were in sufficiently good condition for that purpose. With the exception of *Atenius patescens*, for the determination of which I am responsible, all of the species attributed to his authorship in the following list were identified by him and the specimens represent the originals which served as the bases of his descriptions. Those attributed to my self are either lately published or now in press elsewhere. Ten are described as new. The drawings are made with a camera lucida and represent only what actually remains of the specimens, there being no attempt to restore lost parts or to idealize any of the characters.

As in all collections of fossil insects, a good many of the specimens are in too poor preservation to repay study, but it is possible to recognize the forty-two species listed below.

<p style="text-align: center;">Candide.</p> <p><i>Canthidium tumulorum</i> Scudd.</p> <p><i>Canthidium walcottii</i> Scudd.</p> <p><i>Canthidium</i> Scudd.</p> <p><i>Canthidium</i> Scudd.</p> <p><i>Canthidium whittfieldii</i> Scudd.</p> <p style="text-align: center;">Staphylinidae.</p> <p><i>Staphylinus lesleyi</i> Scudd.</p> <p><i>Staphylinus abaxus</i> Scudd.</p> <p><i>Staphylinus tenebrarius</i> Scudd.</p> <p><i>Staphylinus scottii</i> Scudd.</p> <p><i>Staphylinus</i> Scudd. (?)</p> <p><i>Staphylinus</i> Scudd.</p>	<p style="text-align: center;">Coccinellidae.</p> <p><i>Coccinella</i> Scudd.</p> <p style="text-align: center;">Curculionidae.</p> <p><i>Anthonomus</i> Scudd.</p> <p style="text-align: center;">Dermestidae.</p> <p><i>Dermestes</i> Scudd.</p> <p><i>Attagenus</i> Scudd.</p> <p style="text-align: center;">Byrrhidae.</p> <p><i>Byrrhus</i> Scudd.</p> <p style="text-align: center;">Buprestidae.</p> <p><i>Melanophila</i> Scudd.</p>
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*Monographs of the United States Geological Survey, Vol. XXI and XL.

Lampyridæ.	Cistelidæ.
Podabrus wheeleri Wickh.	Cistela antiqua n. sp.
cupesoides Wickh.	Capnochroa senilis n. sp.
Telephorus humatus n. sp.	Rhynchitidæ.
Trypherus aboriginalis n. sp.	Paltorhynchus narwhal Scudl.
	Trypanorhynchus depratus Scudl.
Ptinidæ.	Otiiorhynchitidæ.
Xestobium (?) alutaceum n. sp.	Evopes occubatus Scudl.
Scarabæidæ.	Eudomus robustus Scudl.
Atenius patescens Scudd.	punguis Scudd.
Aphodius aboriginalis Wickh.	Curculionidæ.
Cerambycidæ.	Geralophus ocellus Scudd.
Callidiopsites grandiceps n. sp.	fossicius Scudd. (?)
Leptura leidy n. sp.	lassatus Scudd.
Chrysomelidæ.	Cleonius primoris Scudd.
Crioceridea dubia Wickh.	Cremastorhynchus stabilis Scudl.
	Anthonomus arctus Scudd.
	Tychius evolatus Scudd.
	Aulobaris damnata Scudd.

Coccinella Linn.

C. sodoma n. sp. (Plate II, Fig. 1). Outline subcircular, of the ordinary form of *Coccinella* if allowance be made for flattening. Sculpture extremely fine, consisting only of the alutaceous roughness common in the genus. Scutellum a little larger than in the recent North American species of *Coccinella*. Length, 7.75 mm.

Type in the Museum of Princeton University, number 6561.

An extended description seems unnecessary, since the figure will show the proportions of the different parts of the body. While it is safer to consider the generic reference as applying in the Linnæan sense, there is nothing about the specimen which would seem to throw it out of *Coccinella* proper. It is a little larger than the average *C. trans-soguttata*, the common species of the Rocky Mountains today. No definite color pattern can be distinguished.

Antherophagus Latr.

A. megalops n. sp. (Plate I, Fig. 1). Form subparallel and moderately elongate, the entire surface devoid of any distinct sculpture though there are faint signs of shallow, broad, elytral sulcations, a few small punctures towards the sides of the pronotum and what seem to be hair marks on the prothorax and elytra. Head large, about one and one-half times as long as the pronotum, slightly longer than wide, sides a little convergent anteriorly, front margin indistinctly preserved, but apparently about truncate. Eyes submedian in position, large and rounded, separated above by less than the width of one of them.

Antennae submoniliform, slightly incrassate exteriorly, first joint large, second short, third longer than the fourth, though not much so, fourth to eighth subequal, the remaining three forming a weak club. The eleventh joint is damaged in this specimen, so that the exact form cannot be made out. Prothorax very short, about twice as broad as long, the form of the sides distorted, one appearing to be straight with the anterior angle distinct while the other is arcuate with the angles nearly obliterated. Scutellum absent or not defined. Elytra about one and one-half times as long as broad, apices, in life probably copulantly rounding through as preserved they are separately subemarginate at tip. Legs wanting. Length, 4.30 mm.

Type in the Museum of Princeton University, obverse and reverse, numbers 6564 and 6535.

The head is larger than in the modern species of *Anthrophagus* that I know and the eyes are of much greater size in the fossil. It may be necessary, some day, to erect a new genus for this insect, but for the present, it seems better to allow it to remain in *Anthrophagus*.

Dermestes Linn.

D. tertiarius Wickh. (Plate II, Figs. 2 and 3). A specimen contained in this collection is in much more perfect condition than the type and shows a few additional features. The head is of normal size and punctured a little more strongly than the prothorax. The male antenna is displayed in sufficiently good preservation to show that it is very similar to that of the recent *D. marmoratus* except that the two joints immediately preceding the club are a trifle broader. The vestiture, punctuation and size are as described for the type.

On account of the imperfection of the type, which was used for the original figure, new drawings from the Princeton specimen are given herewith. The generic reference seems to be completely sustained by this example. It carries the Princeton Museum number 6613.

Attagenus Latr.

A. aboriginalis n. sp. (Plate II, Fig. 1). Form elongate, sub-elliptical. Head of moderate size, deeply inserted in the prothorax, minutely sparsely punctulate, eye rather small. Prothorax about middle a little less than one-half the basal width, side arcuate, dissimilarly so in the specimen, front and hind angles well defined, apical emargination moderately deep, base rather strongly lobed at middle and sinuate each side, disk minutely punctulate or nearly smooth. Scutellum small, triangular. Elytra about three and three-fourths times the length of the prothoracic median line, not striate, punctulate, ribbulate, surface with signs of a fine hairy vestiture. Length, 5.00 mm.

Type in the Museum of Princeton University, number 6290.

The form, size, thoracic outline (especially the shape of the base), the proportions of the abdominal segments and the vestiture all point to this generic assignment. The sculpture seems to have been finer than that of any of the recent North American species with which I am acquainted, and this character will separate it from the fossil *A. sopitus*.

Telephorus Schöff.

T. humatus n. sp. (Plate I, Fig. 2). Form subparallel, rather narrow. Head crushed so as to appear excessively large, particularly since the basal antennal joints are thereby merged with the gena. Eye moderately large, rounded. Antennae equal to a little more than one-half the body length, first joint not distinguishable, second small, third shorter than the fourth, remainder subequal in length, all except the distal three with the inner angles produced so as to appear moderately serrate. Prothorax transverse, sides and apex rounded. Scutellum of normal size, triangular. Elytra four times the length of the prothoracic median line, rounded at apices. Legs rather short. Length, 7.50 mm.

Type in the Museum of Princeton University, number 5984.

In form and size this insect resembles the recent *T. bilineatus* quite closely. The sculpture is of the fine alutaceous type common in the genus.

Trypherus Lec.

T. aboriginalis n. sp. (Plate I, Fig. 3). Form similar to that of the recent **T. latipennis**. Head a little distorted, but evidently of moderate size. Antennae slender, filiform, the joints not serrate, but too poorly preserved to describe as to their relative lengths. Prothorax about as wide as the head, transverse, apex narrower than the base, sides moderately strongly rounded. Elytral length equal to twice the prothoracic width, apices narrowed, but rounded, sculpture strongly scabrous. Abdomen with several segments exposed beyond the elytral tips, without visible terminal appendages. Legs wanting, except one femur, which is rather slender. Length, 8.75 mm.

Type in the Museum of Princeton University, number 6527.

There is little doubt that this insect is closely allied to *Trypherus* if not an actual member of the genus. It has the size, form, sculpture and general appearance of the recent *T. latipennis*, common in the eastern half of North America.

The hind wings are spread and exposed, showing the basal portions of the venation quite well. A comparison of the figure of the fossil with the accompanying one of the wing of *T. latipennis* will show the close general correspondence between them. The dotted lines in the latter figure show as transparent markings on the general ground, but in the fossil the upper one of these is not visible while the lower one seems to have been strongly pigmented.

Xestobium Motsch.

X. (?) alutaceum n. sp. (Plate I, Fig. 5). Form not very elongate, head large, deflexed, eye about circular and rather small compared with that of most recent Anobiini. Pronotum somewhat gibbous dorsally at about the middle, projecting anteriorly over the head. Elytron with a rather weak epipleural lobe within which is a fine but distinct stria, apex apparently rounded. Legs short and only moderately stout. Length, from front of pronotum to abdominal apex, 0.65 mm.

Type in the Museum of Princeton University, number 6575.

In a general way, this species slightly resembles the Florissant fossil *Xylobiops lacustre*, but the proportions are different and the sculpture of the present species is very fine. The entire upper surface shows traces of a minute scabrosity, but the abdomen is almost entirely smooth. The elytra are not striate except inside the epipleural margin. By the small eyes, the size, sculpture and general form, this seems to approach *Xestobium*, but the generic reference must be considered provisional, the most dubious character being the large head.

Callidiopsites n. gen.

This generic name is proposed for a Cerambycid fossil which shows affinities with *Callidium* in the broad short form, short stout antennæ, heavy legs, transverse and nearly or quite confluent front coxal cavities, and coarse elytral sculpture. It differs in the mesosternum, being much narrower between the middle coxæ and the head very much larger. It is not entirely in agreement with any of the recent genera of Callidiodes known to me and it seems better to give it a separate generic assignment. The type is *C. grandiceps*, described below.

C. grandiceps n. sp. (Plate III). Form rather short and stout, outline, as preserved, not unlike some species of *Patrobis* in the Carabidae. Head large, nearly as long as broad and decidedly longer than the prothorax. Eyes not definable. Antennae extending a little beyond elytral two-thirds, moderately stout, the first joint large and thick, third not greatly elongate, tenth and eleventh distinctly shorter than the two preceding. The joints are apparently carinate along their faces. Prothorax very short, a little wider than the head. Elytra (likely enough from abdominal distention due to maceration) not completely covering the dorsal segments, their apices separately rounded, surface coarsely closely punctured with some indication of striation on the outer margins. Thighs heavy, somewhat clavate, especially the middle and hind pairs. Apex of abdomen extruded, displaying a simple, straight sex organ. Length, to extended tip of abdomen, 15.25 mm.; of elytra, 8.25 mm.

Station number 13B. One specimen, collector not specified, was received from Professor Cockerell. The type is in the Museum of the University of Colorado. Another is contained in the Princeton collection, with the number 6543.

This looks like a Carabid, but what can be seen of the structure of the underside together with the large antennae incline to the assignment given above. The antenna figured is a trifle too slender, since it is a camera lucida drawing and the edges of the organ were not entirely freed from the matrix.

Leptura Serv.

L. leidyi n. sp. (Plate I, Fig. 6). Form, judging from the remains, subparallel, as in the recent *L. sphaericollis*. Head apparently incomplete in front of the eye, which is reniform, distinctly emarginate and of rather small size. Antennae not preserved, except a few of the basal joints which are relatively shorter than usual in the living forms. Prothorax a little damaged, but apparently not strongly campanulate. Elytra subparallel to apices which are separately rounded and not much narrowed. Surface sculpture everywhere very fine, the elytra seemingly with a delicate pubescence. Legs moderately long. Length from front of head to abdominal apex, 7.50 mm.

Type in the Museum of Princeton University, number 6512.

The small size will at once separate this from any of the other described species of *Florissant Lepturae*, and the fine sculpture serves to differentiate it from *L. antecurrens* which comes nearest in length. Like the other fossils from *Florissant* ascribed to this genus, it must be considered a *Leptura* in the wide sense only. It is named after Joseph Leidy, zoologist and palaeontologist.

Cistela Fabr.

C. antiqua n. sp. (Plate IV). Form fairly stout. Head finely rather densely punctulate and hairy. Eyes, as shown by their sockets, moderately large. Antennae slender, the basal two joints not dilatate, the remainder sub-equal, scarcely serrate, the distal ones not increased if directed backwards, the antennae would reach nearly to the basal fourth of the elytra. Prothorax broad at base, narrowed at apex, sides gently arcuate, surface finely punctulate and hairy like the head, but more distinctly. Scutellum of moderate size, sculptured like the thorax. Elytra not alike in outline on account of the specimen being crushed askew, but the left one, which seems to be the latter procrust, is a little more than four times the length of the prothoracic median line, tapering to the rather sharply rounded apex. Elytral sculpture and vestiture like that of the pronotum. Legs wanting. Length, from front of head to elytral apex, 13.10 mm.

Type in the Museum of Princeton University, number 6534.

The appearance of this insect is that of a *Cistela* with striate elytra and slender antennae. Compared with the North American species known to me, it comes closest to *C. pinguis* from Colorado. It is about the size of the fossil *Capnochroa senilis*, but that insect has striatopunctate elytra.

Capnochroa Lec.

C. senilis n. sp. (Plate II, Fig. 5). Form elongate, subparallel as far as shown, but the elytral apices are broken off. Head rather large for this genus, transversely finely subrugose. Elytra displayed, transversely elliptical and of good size. Palpi (probably the maxillary) with the terminal joint roughly triangular, moderately dilated. Antennae relatively less elongate than in the recent *C. fuliginosa*, not serrate, second joint shorter than the third, which is not so long as the fourth. Prothorax narrowed anteriorly, the more perfect side almost straight, anterior coxae narrowly separated by the pronotum. Scutellum of moderate size. Elytra long, if complete they would be about six and one-half times the median prothoracic length, rather coarsely striate and punctate. Legs moderate or rather short, not excessively slender, the tarsi, as far as shown, a little shorter than the tibia, claws large, the front ones apparently pectinate. Length of fragment, 12.40 mm.; if entire, the insect would reach about 14.00 mm.

Type in the Museum of Princeton University, number 6502.

While the generic reference must be considered somewhat doubtful, it seems safe to assume that the fossil represents a large *Cistelid* belonging in the same neighborhood as *Capnochroa*. The texture is very like that of the *Cistelidae*, the

prosternum being strikingly like that of *Capnochroa* and setting up strongly in the same way. The arrangement of the coxæ is as in that genus and the front tarsi correspond very well. The form of the palpus is similar. Under high power, the claws show transverse markings, which I think are the somewhat obscured pectinations. The strength of the elytral sculpture is indicated by its showing through, although the specimen is preserved as an underside. A disturbing element is introduced by the antennæ, which are shorter and less serrate than in the modern species, but I dislike to found a new genus upon this character alone. Our living *Capnochroa fuliginosa* occurs in the Atlantic district and as far west as the Mississippi Valley.

EXPLANATION OF PLATES.

PLATE I.

- Fig. 1. *Antherophagus megalops* n. sp.
Fig. 2. *Telephorus humatus* n. sp.
Fig. 3. *Trypherus aboriginalis* n. sp.
Fig. 4. *Trypherus latipennis*, (recent), hind wing.
Fig. 5. *Xestobium* (?) *alutaceum* n. sp.
Fig. 6. *Leptura leidy* n. sp.

PLATE II.

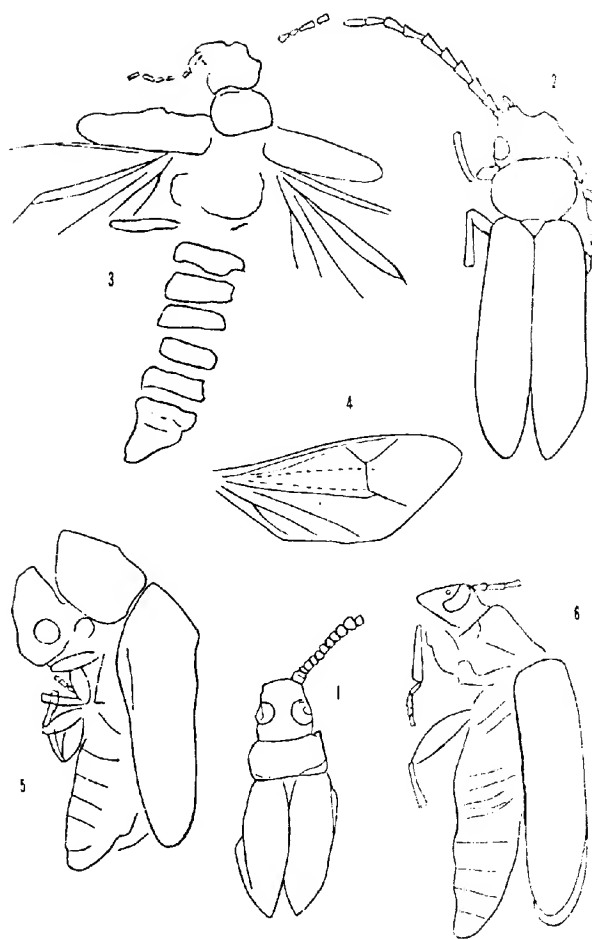
- Fig. 1. *Coccinella sodoma* n. sp.
Fig. 2. *Dermestes tertiarius* Wickh.
Fig. 3. *Dermestes tertiarius*, antenna.
Fig. 4. *Attagenus aboriginalis* n. sp.
Fig. 5. *Capnochroa senilis* n. sp.

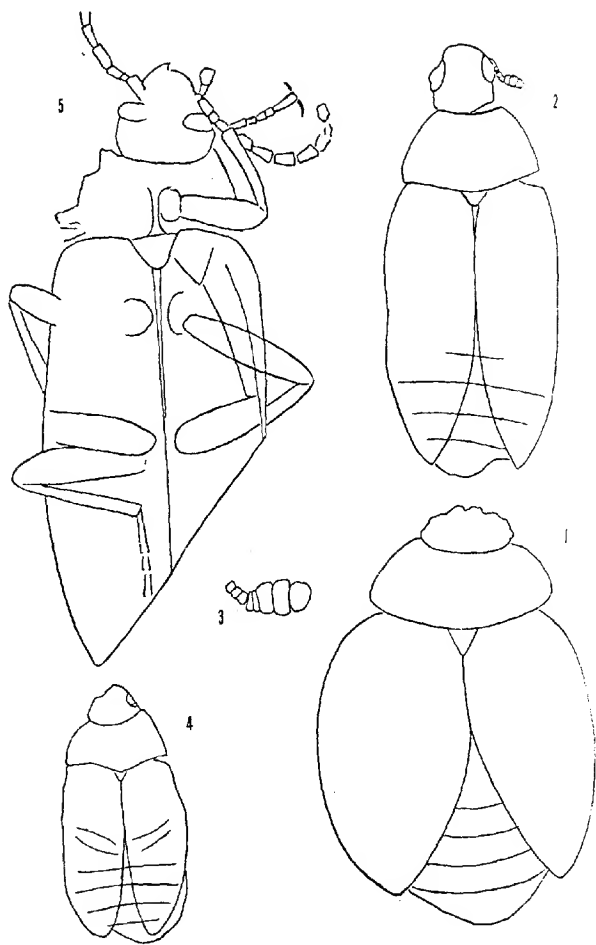
PLATE III.

- Callidiopsites grandiceps* n. sp.

PLATE IV.

- Cistela antiqua* n. sp.









A CONTRIBUTION TO THE BIOLOGY OF MAY-FLIES.*

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I. INTRODUCTION.

This is a study of the habits and structure of May-flies. It describes the situations in which they live and some of the adjustments which they have made to the conditions in them. The two problems which face every organism are those of maintaining its own life and continuing its race. Its youth is devoted entirely to satisfying its individual needs for food and safety; its adult life is devoted to the race, but the necessities of the individual are still satisfied though they may be secured in an entirely different way. The immature life of May-flies is aquatic, and to it all adjustments concerned with food or safety are exclusively confined. The mature or adult life is aerial. It is solely devoted to reproduction. There is no provision for food or for other means of lengthening its life. It gives an opportunity for studying ways of getting a living which have been completely isolated from ways of reproducing. The study which follows has been divided into five sections.

1. The historical sketch, in which the more important papers which have dealt with May-fly biology are briefly discussed.

2. The life cycle which consists of a brief statement of the characteristics of the three stages of life.

3. The evolution of the nymphs in which progress from a generalized to a specialized condition is shown in changes of shape and function of gills, mouthparts, and legs.

*Contribution from the Limnological Laboratory of Cornell University. This work was done under the direction of Professor James G. Needham, of whose kindly criticism and stimulating interest I wish to express my appreciation. I wish also to thank Miss Anna C. Stryke for her many helpful suggestions regarding the drawings and the photographs from which some of the drawings have been taken.

4. The evolution of the adult in which specialization is shown by changes of function and developments for the furtherance of reproduction.

5. Adjustments for aquatic situations shown in the structures of the eggs.

6. A Bibliography of biological, morphological, and the more important systematic works dealing with this group.

II. HISTORICAL.

In the following historical sketch I have tried to select the more important papers of biological significance. In many cases, however, systematic, morphological, and biological work have been so closely related that such a separation has been impossible.

Swammerdam. 1661. The foundation study of the biology of May-flies was made by Johann Swammerdam, at Culenburg, on the Rhine, in 1661. As a field naturalist, he learned the most important facts concerning the life of *Ephemerus*, (probably *Palingenia longicauda* Oliv.). As an anatomist he dissected and studied its internal and external structure with great care. He described the emergence of the nymph, the sub-imago stage in males, and the final or imago stage in which he believed that the eggs and the sperm were deposited separately in the water. He concluded that no food was taken during aerial life, and that copulation did not occur. He examined the eggs and tested their power of dispersal by letting them fall into the water from the end of a knife. His work is a remarkably truthful and interesting record. Later works have added and corrected, but none have contributed better biology.

Reaumur. 1742. In *Memoires des Insectes*, 1742, Reaumur reviewed much which had already been told by Swammerdam and illustrated more profusely the life history of a burrowing May-fly, probably also *Palingenia*. Some of Reaumur's observations were made upon nocturnal species. After he had noticed them swarming about a light near the river bank, he placed a tub of water in his own garden. By holding a light above this, in the evening, he was able to gather great numbers of May-flies and to watch their transformation from the sub-imago to the imago stage, and to see them lay their

eggs in the water. He counted the eggs which he found protruding from the abdomens and determined the average number to be 750 to 800 for each female. He disagreed with Swammerdam regarding the fertilization of the eggs, and stated that the males and females probably did mate, and that the forceps of the male were evidently for the purpose of seizing the female.

DeGeer. 1748. In 1748 DeGeer saw the mating^{*} actually take place. Two years later he again saw the mating flight and the mating, and this time was able to give more facts concerning it. The swarm consisted mostly of males. In mating the male was beneath the female with his abdomen recurved upward so that its tip rested against the two openings of the oviducts, between the eighth and ninth segments. Copulation lasted but an instant, and De Geer was not able to observe the process in detail. He described several different varieties of May-flies, distinguishing them by descriptive color names. The double eyes of a diurnal May-fly (possibly a *Leptophlebia*) were mentioned, the larger eyes being named the turbinate eyes.[†]

Geoffroy. 1764. Geoffroy, 1764, saw great swarms of May-flies near Paris and noted that there they were called "manne de poissons," because great numbers fell down into the streams to the fishes. He accurately figured and described as a Crustacean,[‡] the May-fly, later determined by Vay liere as a Prosoptoma, which he found in the riffles of a stream near Paris.

Newman, 1836. In discussing the transformations of insects, Newman, 1836, wrote of May-flies as follows: "Here then we have the strange fact of an insect's flying before it reaches the imago; that is, flying in the penultimate state. It thus appears that although until the final ecdysis, no insect arrives at perfection; yet before that period, even in the state immediately preceding, it may feed, run and even fly; or it may swim, crawl, barely move, or be without motion."

Bowerbank, 1833. Bowerbank studied the circulation of the blood in young nymphs of *Ephemera marginata*. He carefully examined the dorsal vessel with its valves and described the circulation of the blood. He was the first to see

^{*}DeGeer, 1748, T. II, p. 644.

[†]DeGeer, 1748, T. II, p. 651.

[‡]Geoffroy, Tom. II, p. 658. "Le Binocle a quere en phre." "

in the setæ the two currents of blood which have since been carefully studied.

Westwood, 1840. In 1840 Westwood discussed the classification of May-flies, following the discussion with some biological facts mostly gathered from previous writers.

Burmeister, 1848. Burmeister made the first real contribution to May-fly embryology. While sitting in his room one evening, many females of *Palingenia horaria* flew through the open window and began depositing eggs upon his table. Burmeister described these eggs and figured them. He placed some of them in water on July 22 and on August 2 he freed an embryo from the shell. He studied this stage carefully and figured it showing the mouth-parts, legs and gills.

Leuckart, 1858. Ten years later Leuckart carefully described the eggs of three May-flies. This work was followed by

Grenacher, 1868. Grenacher's short, but important paper, "Beitrag zu Kenntniss des Eies der Ephemeriden." He studied eggs similar to those cited by Leuckart and showed that the polar knobs described by him were to be found in various stages within the ovary. So far as known, Leuckart and Grenacher have been the only authors who have made any careful study of these egg structures in May-flies.

Pictet, 1843. The first general study of this group was the monograph in the "Historie Naturelles des Insectes Neuropteres" by Pictet. He classified preceding biological and systematic studies and gave a history of each, reviewing all of the most important contributions from Aristotle to 1840. He described the habits of his four classes of nymphs, fossorial, flattened, swimming and crawling. He discussed the emergence of the nymph and features of the sub-imago and imago stages, but he gave many details less satisfactorily than Swammerdam or Geoffroy.

Dufour, 1849. In 1849 Leon Dufour published a memoir on the different kinds of respiration in insects. In this he classified May-flies with insects breathing by means of external organs. This study was followed by the similar ones of Mueller, 1851, and Milne Edwards, 1857.

Lubbock, 1863-6. After the first contribution to May-fly embryology by Burmeister in 1848, no further investigations were made until 1863-6, when Sir John Lubbock published two papers, "On the Development of *Chloeon dimidiatum*."

In these two studies he followed individuals through twenty or three successive moults, tracing them to the adult stage. He did not, however, begin his observations at the actual time of hatching as Burmeister had done.

Hagen, 1849-1890. The foundation for the study of May-flies in North America was made largely through the inspiration and contributions of Prof. Hermann Hagen. Although the greater part of his work was systematic, the notes which he sent to Eaton in 1873 show that he made valuable additions to the knowledge of their biology. Hagen identified the nymph of *Baetisca* which B. D. Walsh described in 1864.

Walsh, 1864. Walsh concluded his paper on *Baetisca* with a description of the swimming habits of the nymphs which he kept for some time under observation.

Eaton, 1870. About the end of 1870, Rev. A. E. Eaton submitted to the Entomological Society of London the most important work done upon the group since Pietet's monograph. In 1883-86, the completed work was published in the Transactions of the Linnean Society.

Eaton, 1883. In this work the world fauna was reclassified and a great number of forms were described and figured with such accuracy that it at once became and has remained the most important work upon the order. The introduction contained a general account of the biology which included several of Dr. Hagen's* field notes.

N. Joly, 1876. Joly, '76, studied the embryology of *Palisania virgo*. He kept eggs in dishes of water and recorded the structures of the developing embryo on the 5th and 6th day. This work was followed by another by N. and E. Joly, which dealt mostly with the structure of the systems in the nymphal and imago stages of certain species.

Vayssiere, 1882. Vayssiere published the first extensive study of the nymphs. This paper was written almost entirely from a morphological view point, but it contains many references to short biological papers.

The papers of Zimmerman, '79, Eaton, Hagen, Joly, Palmer, '81, Creutzburg, '83, and others were mainly morphological.

*1873. Hagen Notes on the Ephemeridæ. Compiled by Eaton.

Fritze, 1889. Fritze, '89, studied the structure of the alimentary canal. He described and figured a muscular apparatus in the oesophagus, and discussed its changes of function in the adult.

Heymons, 1896. In a paper upon the embryology of *Ephemera vulgata*, Heymons, '96, stated that the eggs hatched eleven days after they were laid. He traced the development of the nymphs up to the age of four days. He discussed the ancestry of May-flies, and concluded that their life was originally entirely aerial and that the closed tracheal system of the nymphs is an accommodation to aquatic life.

Causard, 1896. Causard noted the birth of living young in *Ephemera vivipara* and briefly described the development of the nymphs.

Hubner, 1902. Hubner, '02, tested the regenerative powers of nymphs of *Cloeon dipterum*. Certain nymphs regenerated the last abdominal segment with its appendages. The alimentary canal became functional, and the insect lived for one month.

Tumpel, Needham and Betten, 1901. In the same year two general papers were published. "Die Geradflügler Mitteleuropas" by Tumpel and several complete life histories in "Aquatic Insects of the Adirondacks" by Needham and Betten.

A similar but much more extensive work by Needham followed in 1905 and 1908. In the introduction to this study May-fly nymphs were described as "perhaps the dominant insect herbivores of fresh water." Their herbivorous diet and their importance in the economy of aquatic life were for the first time emphasized.

Sternfeld, '07. Sternfeld, '07, worked upon the atrophy of the mouth-parts and the changes in function of the alimentary canal. He reviewed Fritze's paper and considered the biological significance of the structures much more fully. He concluded that the alimentary canal in imago May-flies is by no means rudimentary and that a muscular apparatus, which is under voluntary control, regulates the supply of air in it. The decrease of specific gravity caused by this "swimming bladder" aids the insects in the mating flight and hence indirectly influences their multiplication.

Drenkelfort, '10. *Drenkelfort* wrote a general account of the biology of *Siphurus lacustris*.

Wodsedalek, '11. *Wodsedalek* experimented upon nymphs of *Heptagenia interpunctata* Say and found that they were repelled by light, but that these reactions could be reversed by the addition of certain chemicals to the water.

III. LIFE CYCLE.

The life cycle of May-flies includes the embryonic period within the egg, and the active life which is divided into nymphal, sub-imago and imago stages.

Almost the earliest studies of the embryos were made by *Burmeister*, '48, who described those of *Palingenia horatia* twelve days after laying. He noted the rudiments of the mouth parts and legs. According to *Joly*, '76, embryos of *Palingenia virgo* take about two months for development. *Heymons*, '96, found that eggs of *Ephemera vulgata* kept in a temperature of 20-25 C would hatch in ten to eleven days. At hatching they measured 1 mm. with setae inclusive. The antennae and setae were respectively five and four segmented. External gills were not yet present, but all of the systems were complete except the reproductive. On segments two to seven of the abdomen was a series of lateral hypodermal thickenings. *Heymons* believed that the gills which arise four days later were outpushings of these thickenings. He held the gill to be lateral projections homologous with the leg, and not of dorsal origin as often considered. From the structure in the embryo he concluded that a homology between gill and wing is unfounded.

By nymphal stage is meant the period of life between hatching and emergence from the water. The exact limits of its duration are unknown. *Lubbock*, '66, followed a *Chironomidium* through twenty-three moults to the imago stage, but his data does not begin at time of hatching. *Hexagenia viridabilis* lays its eggs in April and May, but I have found large and small nymphs abundant in the same locality in the March preceding, so that they must require at best two years to mature. Nymphs of *Callibaetis fluctuans* mature in about six weeks in mid-summer. As already noted, May-flies find the egg in a fairly advanced state of development. Their

are very active and nearly all are voracious herbivores. The nymphal period is one of extreme competition and during it the nymph must find safety, and get food sufficient for its entire life. With the exception of the Diptera, May-flies are the dominant aquatic insect herbivores. They have attained this position by utilization of a vegetable diet and by remarkable adjustments to particular situations. The population about them is divided into two classes, competitors and enemies. Their competitors are mostly insects, which, like the May-flies, live upon herbivorous or nearly herbivorous diet; among them are the larvæ of Caddis-flies (except the *Hydrosychidæ*), Crane-flies and most of the smaller Diptera. Their enemies are wholly or in part carnivorous. Important among them are the nymphs of Dragon-flies, Stone-flies, many beetles and the Hemiptera and Neuroptera. The adolescence of the nymph is evidenced internally by the development of the reproductive organs, and externally by the growth of rudimentary wings. This stage is terminated by a gradual change in organs of locomotion, respiration and digestion and by the final casting off of the nymphal skin.

The first winged or aerial stage is known as the sub-imago. The general form of body differs little from that of the actual adult insect. The wings are fully expanded and direct respiration through open spiracles is established. All surfaces are dull and in most cases the wings have a prominent marginal fringe of hairs. A few May-flies (females of *Palingenia* and *Campsurus*, Eaton '83) never lose the sub-imago skin, but in nearly all it is shed. The duration of the sub-imago stage varies from a few minutes in the most ephemereal species to several days. Needham,* '08, has given this account of *Caenis diminuta*. "It is the most ephemeral of all Ephemera. It emerges from the water at nightfall, leaving its nymphal skin floating on the surface, and, alighting on the first support that offers, sheds its skin again, and the sub-imago stage is ended."

*N. Y. State Bull. 124, p. 178.

The following data upon some of the longer lived species shows its average length:

Heptagenia interpunctata	♂	2 days	=	length of sub-imago life
"	"	♂ 1	"	"
"	"	♀ 1	"	"
"	"	♀ 1	"	"
Siphonurus alternatus	♀	2	"	"
"	"	♂ 2	"	"
Ison fragilis	♂	2	"	"
"	"	♂ ♀ 2	"	"
"	"	♂ ♀ 2	"	"

Sub-imagos are very inactive and in nature spend the day-time resting in the shade, often upon the under side of leaves near the stream from whence they emerged. In captivity they are just as inactive, but if confined in very narrow quarters, they almost invariably fail to transform successfully. During this stage the legs, especially the front ones, and setæ are elongated and the reproductive system matures.

That this sub-imago stage is peculiar to May-flies is a well known fact. Little light, however, has been thrown upon its actual significance and analogy to the stages of other orders. Boas, '99, suggested that the sub-imago stage once had a wide distribution among Orthoptera which have now died out; that this corresponds to the pupal stage of holometabolous insects; and that the Ephemeridæ show a transition toward perfect metamorphosis. He believed that there was nothing in the form of Neuropterous pupæ which contradicts the theory that they have been developed out of such sub-imago stage.

The single molt of aerial life is followed by the mature or imago stage. At the beginning of this stage the eyes, legs and setæ attain full size. All surfaces of the body are shiny and the wings are transparent. The duration of this, like the sub-imago stage, varies greatly with the species. It varies also with the individual. Males which have mated are said to live a much shorter time than those kept in captivity.

Imagos are usually active at special times. Those of diurnal species fly freely at all hours of the day, but oftenest are seen in mating flights during the late afternoon. The nocturnal

May-flies must swarm in like manner at night is testified by the great numbers often caught in webs in the early morning. The important functions of this stage are the fertilization and laying of the eggs.

IV. MODIFICATIONS OF STRUCTURES OF THE NYMPH.

Nymphs of Ephemerinæ and Heptageninæ (Needham) live fairly within the limits of two ecological situations. The Ephemerinæ inhabit mud or muddy water exclusively. Most of the Heptageninæ live in riffles of streams or upon the washed shores of lakes. The Bætinæ inhabit gentle currents or open waters and intermingle with the mud and casual dwellers as well. They have become adjusted to very different situations and they show a wide range of specialization.

All of the Ephemerinæ which have been found here live in the same situation and are very similar in their habit of life. Ephemera and Hexagenia are true burrowers in the mud. Polymitaerays occasionally adopts the digging habit and Pseudamantus crawls upon silt covered stones and muddy bottoms in the same locality.

The members of the Heptageninæ are also very homogeneous habit. They live in running water, clinging or moving about upon the under sides of stones. Iron and Ephemis dwell in the swiftest water of the current, in riffles and falls. Ecdyurus and Heptagenia live in the gentle currents along the borders of the stream and sometimes beneath the stones in quiet pools.

The Baetinæ dwell in a variety of situations. Siphonura and Callibaetis clamber upon the aquatic plants or dart about on the alga covered bottoms of still pools and inlets, while Ameletus more often frequents moving waters and nymphs of Blasturus hide among decayed leaves in ponds and brooks. Leptophlebia and Habrophlebia cling closely to the surface of stones, usually upon the under side and often in fairly rapid water. Most members of the genus Ephemerella have a similar habit, but there is a wide divergence among the species of this genus. Two genera, Baetis and Chironomus, are dwellers in water falls, and the latter has become remarkably well adjusted to its habitat. Tricorythus and Caenis are adjusted to life in mud and sand and show structures especially well fitted to their surroundings. These two extremes of

specialization are examples which show the variety of adjustments within this family. As later discussion will show, they also show what diverse structures may be arranged to equally well for life in the same or similar situations.

Since the outside of an animal is the first to be influenced by environment, the most important adjustments must be looked for in external structures. In this study only the three most important sets will be considered; those which have to do with respiration, food and motion.

SHAPE OF BODY IN THREE SUBFAMILIES OF MAY-FLIES.

Before attempting to trace the adaption in the three sections just named, it is necessary to briefly describe the general shape of the nymphs in the three subfamilies.

The bodies of the Ephemerinae are elongate, more or less cylindrical and tapering at either end. Those of *Ephemera* (Pl. XLIV, Fig. 8) and *Hexagenia* are almost perfectly cylindrical. The heads are wedge-shaped with the mandibular tusks projecting sharply in front. The bodies of *Polymitarcyx* and *Potamanthus* (Pl. XLIV, Fig. 7) are flattened. The head of the latter is short and broad with the mandibular tusks barely showing beyond the labrum. A comparison of *Ephemera* (Plate XLIV, Fig. 8), with *Potamanthus*, will immediately show *Ephemera* to be the burrower.

In the Heptageninae, the head, the body and all its appendages are depressed. In *Iron* and *Epeorus* (Pl. XLII, Fig. 1), which inhabit the swiftest water, this depression is greatest, but in *Heptagenia* and *Ecdyurus*, it is also very pronounced.

The form of the Baetinae is various. The most representative is the slender compressed body and rather small rounded head which is characteristic of the active nymph-like *Callibaetis*, *Ameletus*, (Pl. XLIII, Fig. 5 and Pl. XLII, Fig. 3a). All of these nymphs have long legs for running and jumping, but in another type, the body is shortened, more or less flat upon the ventral side, and thickened through the metathorax. Such a form is represented by the majority of the Ephemerellae. It is most marked in the very short stubby bodies of *Cnemid* and *Tricorythus*, which have become exclusively mud dwellers. In *Platysturus* (Pl. XLII, Fig. 1) there is a tendency to a depressed form. This is more pronounced in *Choroterpes*, which is strikingly similar to the Heptageninae.

ADJUSTMENT TO ENVIRONMENT SHOWN IN THE STRUCTURE OF
THE GILLS.

The gills of May-flies are especially susceptible to modification by the character of their surroundings. They are usually large and prominent. In other aquatic insects they are less directly exposed. Those of stone-flies are generally tucked behind the legs upon the ventral side of the thorax and those of damsel flies at the hind end of the body. May-flies have seven pairs of gills, one borne at each posterolateral angle of the first seven tergites. They are usually large, sometimes unweildy and always a conspicuous feature of the body. Situated as they are, they extend along the whole side of the abdomen and brush against everything with which it comes in contact.

The gills of *Leptophlebia* are the most generalized of any which have been examined. They appear to lack modifications both for respiration in any particular situation or for protection. The seven pairs are identical in shape and nearly so in size. Each one is entire at the base, but deeply cleft into two long narrow divisions which lie in one plane. Their surfaces are without markings or local thickenings. One large trachea enters the gill and sends a branch to each of its divisions. In these there is but a scanty supply of tracheoles. The attachment to the abdomen is exposed above and below so that the only protection for the gill is in the ease with which it may be detached and regenerated.

In *Blasturus* the first pair of gills are like those of *Leptophlebia*, but the other six pairs are broadened so that a much greater respiring surface is provided. At the base a trachea enters and splits once, but each arm gives off a good number of branches which supply the whole surface of each gill division or lamella. The two lamellæ do not lie in the same plane, but the outer one is twisted over at the base and lies on top of the inner. A double gill made of two overlapping lamellæ is thus formed. A variation of this same kind of development is shown in the gills of *Choroterpes*. These gills have neither ribs, nor bands upon their margins. In consequence of this they hang limply from the sides of the body, but the main tracheæ provide some leverage for the muscles, and the gill

can be moved a little. The breathing movement is, however, weak and feeble. The nymphs are thus provided with large breathing organs, but also burdened with an unwieldy load.

In *Siphurus* the gills are double and are stiffened by strong tracheae and moved by muscles at the base, so that they can be held upright and can also be vibrated with great rapidity. In addition there are narrow spinous bands upon the inner edges of the upper lamellae. Those of *Callibaetis* (Pl. XLIII, Fig. 5), are held in upright position, and can be rapidly vibrated like those of *Siphurus*. They are much smaller and lie farther dorsad when pulled down close to the body. They are better protected because less conspicuous, and better breathing organs because their rapid vibration enables them to absorb as much oxygen as if they were broad and bulky.

In the gills of *Baetis* the marginal bands are hardly indicated, but those of *Ameletus* are broadly bordered by thick spinous bands of chitin. In them the single lamella is fairly supplied by tracheae. Its base is inserted into a shallow notch in the posterior margin of the tergite. Its attachment is thus slightly protected and at the same time it is allowed to swing freely. Adjustment to the conditions in water falls is always marked by an increase in the tracheal supply. In *Chironetes* (Pl. XLVI, Fig. 13), this has been made by a great increase in the number of fine tracheoles which supply the lamella and by the development of a fimbriate gill at the base main trachea of which is a branch of the main trachea of the lamella. The margins of the lamella are bordered with thickened spinous bands similar to those of *Ameletus*, but it has also a stiff rib extending from base to tip.

A second group of *Baetinae* in which the gills are much specialized includes those which have been adjusted to an environment of mud and sand. Nearly all of these nymphs have the number of gills reduced. In *Ephemerella excrucians* there are but five pairs of gills and these cover but two abdominal segments. The attachments are in every case protected by lateral spinous extensions of the abdomen. In *Ephemerella rotunda* and *E. excrucians* a wide hollow held informed from these spines, upon which the gills rest. Each gill consists typically of a thickened lamella, which completely shields the delicate fimbriate-lamelliform division beneath.

The thickening of the upper lamella is greatest upon the first gills. This thickening and the reduction in number of gills is most marked in the two mud dwellers, *Cacis* and *Tricorythus*. In these, gills are present upon segments 4 to six only. In all species of both genera the upper lamella of the first gill is modified into a cover which conceals all those behind it. They are further protected by a shelf-like extension similar to that just described in *Ephemerella*. In the slight concavity of this shelf lie the delicate gills of segments 4, 5, 6, protected from the harsh gravel through which the nymphs crawl. When breathing actively the stiff covers are raised enough to allow water to circulate upon the gills beneath, which vibrate freely and create a current.

The gill covers of *Tricorythus* are scoop shaped, with the concavity beneath, so that even when the cover is closed down the gills are not under pressure, but are enclosed in a protecting box. The edges of the cover and those of the gill beneath are margined with short hairs. This brush of intermingled hairs makes an effective sieve which strains out particles of mud from the incoming current of water. Entrance of water at the base of the gill is prevented by a small triangular extension of the second abdominal segment which fits closely to the inner side of the elytroid cover.

Gills of the Ephemerinae.

The most homogeneous series of gills is found in the *Ephemerinae* which in Fall Creek were represented by *Potamanthus*, *Polymitarcys*, *Ephemerella* and *Hexagenia*. They are single and rudimentary upon segment one, (Pl. XLIX, Fig. 27) and double upon segments 2-7 (Pl. XLIX, Fig. 26). They are linear and generally narrow, but this varies slightly with the genus. The upper and lower lamellae are both fringed with filaments into which run branches of the tracheae. The attachments are not protected and the base of the gills appears to be an unbroken continuation of the body wall, which is very flexible and tough. The gills of *Potamanthus* (Pl. XLIV, Fig. 7) are the most generalized. They are nearly linear, lie linearly extended from the sides of the body and except for the scanty fringe of filaments are almost identical with the gills of *Leptophlebia*.

In the true burrowers, *Ephemera* (Pl. XLIV, Fig. 8) and *Hexagenia* (Pl. XLIX, Figs. 26, 27) both lamellae are broader and the number of the marginal filaments is more than doubled. Each lamella is stiffened by a mid-rib of chitin which over-arches the main trachea. By the aid of this rib the gills can be held up over the back where they are not exposed to the constant friction as they would be when trailing from the side.

Gills of the Heptageninae.

The gills of the Heptageninae (Pl. XLV, Figs. 10, 11, Pl. XLVI, Fig. 12) show a series of slightly less homogeneous adaptations. They are fitted for breathing in different degrees of rapid water, and at their maximum specialization, they are important aids to the nymph in clinging to surface. The gills are double except the last one which in *Heptagenia* is rudimentary. (Pl. XLV, Fig. 10). The upper division is plate-like and shows greater modification and the lower part is fimbriate-lamelliform or fimbriate, and varies slightly in size and position among different genera. The gills of the *Heptagenia* and *Epeorus* have the characteristic abundant tracheation of swift water inhabitants. In *Epeorus* the lamellae are large, richly tracheated and lie obliquely recumbent along the sides of the body, (Pl. XLII, Fig. 4), so that the tip and outer edges touch the surface upon which the nymph rests. Along this edge is a chitinized band thickly bect with spines. When clinging to stones in the rapid current this edge is pressed tightly down to the surface. The bases of the gills are protected by sharp extensions of each tergite, which project backward over them. On the inner margin of each lamella near the base is a shallow notch. When the lamellae are held close to the body the fimbriate gill projects through this notch and receives the full wash of the water. The first pair of lamellae are scoop-shaped and curve inward back of the hind legs so that little water flows beneath the body.

In *Iron fragilis* there is a similar, but more perfect adhesive apparatus. The outer margins of the lamellae are likewise bect and their position is identical with that just described. The first pair of lamellae are much larger. (Pl. XLVI, Fig. 12), and their tips are held almost in contact. The last pair are added and slightly curved so that the tips of the ends nearly touch. When the margins of these lamellae are closely pressed

against the surface a sucking disk is formed. In the lamellæ and in the fimbriate gill above, the tracheæ absorb oxygen from the water constantly flowing over them. An adhesive apparatus is thus coupled with an efficient respiratory organ.

The Food of the May-fly Nymphs.

May-flies are almost entirely herbivorous. Their food consists chiefly of fragments of higher plant tissue, algæ and diatoms. The following table contains the record of an examination of the stomach content of several nymphs. With the exception of *Siphilurus* and *Chironomus* the examinations were made upon fresh material:

STOMACH CONTENTS OF NYMPHS EXAMINED THROUGH APRIL AND MAY. CROSS
(X) REPRESENT SUBSTANCES FOUND IN MORE THAN TEN
SPECIMENS OF A GENUS.

	<i>Siphilurus</i>	<i>Heptagenia</i>	<i>Blasturus</i>	<i>Hexagenia</i>	<i>Gallagheria</i>	<i>Chironomus</i>
1. Fragments of Plant Tissue.						
Stems, decayed leaves.....	X	X				
Epidermis.....	X	X				
Epidermis, moss.....	X	X				
Epidermis, roots.....						
2. Filamentous algæ.						
Vaucheria.....	X					
Spirogyra.....	X				X	
Mougeotia.....	X					
Ulothrix.....	X				X	
Zygnema.....	X					
3. Diatoms.						
Navicula.....	X	X		X		
Fragellaria.....	X	X	X			
Tabellaria.....	X	X				
Cocconeia.....		X	X	X		
Meridion.....			X			
Gonphonema.....			X	X		
Synedra.....						
4. Animal.						
Mayflies.....	X					
Other insects.....						

The kinds of algæ and diatoms found in the stomach varied a good deal with the locality and date of collection. In certain parts of Cold Brook during March, 1911, every available object was brown with *Meridion* and the stomachs

of nymphs collected there contained little else. Nymphs taken in the same place a month later contained no fragment of *Meridion*. May-fly food is most abundant in April and May, especially for the running water forms. Later the thick mats of *Meridion*, *Cladophora* and *Spirogyra* begin to decay, there is a diminished supply of water and consequently greater competition for food.

In the summer of 1911, a few experiments in feeding were made upon *Callibaetis fluctuans*, one of the most abundant local May-flies in pools and open waters. Six pails about one foot deep and seven inches in diameter were made from strong muslin. A ring of wire was placed at top and bottom to extend them. A string was tied into the upper one for a bale and the pails were fastened to a frame and suspended in a pool where the water was kept constantly fresh. They were numbered 1, 2, 3, 4, 5, 6, and a different food placed in each respective pail.

On June 28, twelve nymphs of equal size were measured and freed in pail. On July 1, nymphs were taken from each pail and the stomach contents examined. For ten days more the same food was given at intervals of two days. Occasionally the pails were rinsed free of stale food. This was especially necessary for the corn meal which soured quickly.

June 28 12 Nymphs in each Pail	July 1 Alive	July 1 Stomach Content	July 10 Alive
1. Fruiting chara.....	All	Not much food, fragments of chara.....	All
2. Corn meal.....	All	Half full of meal.....	6
3. Alfalfa (ground).....	All	Not much food, fragments of alfalfa.....	9
4. Spatter-dock (ground).....	None	Full of spatter-dock tissue.....	7
5. Green grass (ground).....	7	Half full, green grass.....	7
6. Fruiting chara (control)...	All	Full of chara.....	All

The mouth-parts of May-fly Nymphs.

Batinae

The most generalized mouth-parts occur among the *Batinae* in the species which bite or tear fragments from roots and stems. They consist of labrum, labium, mandibles, maxillae, hypopharynx, and the epipharynx which is borne upon the labrum. Those of *Callibaetis fluctuans* (Pl. XLVII, Fig. 14),

are typical of this generalized condition. On the concave inner surface of the labrum are two patches of incurving hairs, and these are supplemented by a set of long marginal hairs. When gathering food the edge of the labrum is pressed against a stem or leaf and moved rapidly back and forth. After a few movements its tip is pulled close to the mouth and brushed by the maxillary palpi. The labium sweeps food in from behind as the labrum does from the front. On the maxillæ which lie in front of the labium the lacinia and galea are fused. The lacinia is represented by two teeth on the tip; the galea by the lobe like part behind them. The teeth of mandibles are separated into two distinct groups, the canines (c) and the molars (m). In many cases both of these are very asymmetrical. Both maxillæ and mandibles may be freely extended side wise, but the latter is used less often for biting than for grinding. The epipharynx (cf. Pl. XLVII, Fig. 14b) is an inconspicuous elevation which is borne on the inner surface of the labrum. It is densely covered by short incurved hairs probably sensory. It often extends on to the clypeus and in all the nymphs examined lies a little to the right of the center. Mouth-parts of the type described above are found in nymphs of *Siphurus*, *Blasturus*, *Baetis* and *Leptophlebia*. The food getting habits of any of these can be easily observed. They pull off fragments from the stems and leaves by sticking the lacinia or less often the canines into the tissue, then bracing with the front feet and pulling backward. Upon flat surfaces, they keep the labrum and labium moving rapidly and thus sweep the food into the mouth.

In nymphs of *Ameletus ludens* a broad plankton rake upon the maxillæ formed by a series of arched, regularly graduated, and pectinated hooks borne upon the distal end of the galea and lacinia. When eating, the nymph extends these rakes forward and backward, exactly as one would use a hand rake and by the help of the labium and hypopharynx the food is pulled into the mouth for grinding.

Nymphs of *Chironetes* gather their food upon ledges washed by dashing water. The outer surfaces of the mouth parts are armed with very long bristles. The distal segment of the labial and maxillary palpi are flattened out into broad blades. These blades are used as scrapers upon the algæ covered stones. In the swift current this nymph must of necessity

ding to the rocks with its head upstream. In doing this it uses its fore legs little, but they are held up and straight forward close beneath the labium. Armed with long bristles as they are, they help to form an efficient plankton basket which catches the food carried along in the water.

In *Caenis*, *Tricorythus* and *Ephemerella* the mouth-parts are often reduced. In all these the mandibles are stout with very strong canines (Pl. XLVII, Figs. 16, 19, and Pl. XLVII, Figs. 20, 21). Structures like the palpi which extend out from the mouth are much shorter. In *Tricorythus* (Fig. 22), the body of the labrum is strong, but the palpi are weak and stubby. This reduction is carried to the limit in the maxilla of *Ephemerella deficiens* in which the palpi have disappeared, leaving only a little peak of chitin at their attachment place (Fig. 18). If one observes nymphs of *Tricorythus* or *Ephemerella* foraging, they will see them continually thrusting their heads through harsh gravel where such appendages would be in the way.

The *Bætinæ* have the most generalized mouth-parts examined. This group includes species in which there have been modifications of the mouth-parts for rakers and plankton baskets, and great reduction of palpi.

Ephemerinae

Nymphs of *Potamanthus*, *Polymitarcys* and *Hexagenia* all gather their food in the same places and by the same means. Their relative specialization has been closely correlated with the extent to which they have been modified for burrowing. The mandibles of *Potamanthus* (Pl. XLVIII, Figs. 23 and 24) show the beginning of this modification. The canines are here in their usual position at the tip of the mandible (c), but upon the outer side of each is a stout pointed process. These processes are not long, and when the mandibles are in natural position only their tips show beyond the labrum. These processes are similar in shape and identical in position with the tusks of the true burrowers, *Ephemera* and *Hexagenia* (Pl. XLIX, Figs. 31, 36). In these the processes are long, slightly incurving tusks which are the most conspicuous features of the head. The canines are on the median side of these near the base, and when the mandibles are in natural position, they extend downward and can thus most efficiently grasp

food. From them the food is passed inward to the grinding surface of the molars. Upon the left molar (Pl. XLIX, Fig. 34) are eight deep transverse gutters. The upper ends of these are enclosed by irregular teeth and the floors are marked by transverse striations. The right molar (Fig. 35) surface bears seven overlapping ridges, all but one of which is bluntly toothed and enclosed at one end by a prominent jagged process. When in position the ridges of the right molar fit down into the gutters of the left and the terminal teeth fit into the free ends of the gutters. The food brushed into the mouth by the labium and maxillæ is ground in this mill.

In the Ephemeringæ the greatest modification has occurred in the mandibles which have become the strongest structures of the head, important alike to feeding and burrowing.

Heptageninæ.

In the Heptageninæ which have scraping mouth-parts, the labrum is entirely hidden from above. It is freely movable upon the clypeus and has a row of very dense, slightly incurved hairs extending along its margin. The inner surface of the labrum is slightly concave, and bears the epipharynx. When the labrum is extended forward the short hairs upon the inner surface rake in the food and are closely followed by the thick brush upon the margin. Food thus gathered in the concavity of the labrum falls directly between the maxillæ and mandibles.

Legs of Nymphs.

The legs of May-fly nymphs consist of a coxa, trochanter, tibia, tarsus and a tarsal claw. These parts vary in relative size and structure according to the habit of the nymph. The surfaces may be bare, scaly, spinose or hairy. In all of the legs which have been examined there is a small but distinct plate on the inner side at the distal end of each tibia.

Bætinæ.

The Bætinæ includes nymphs which have the most generalized legs, such as those of *Siphurur*, *Callibætis*, *Ameletus* and *Chironetetes*. All of these nymphs can move about upon a heterogeneous footing (Figs. 3 and 5). The legs of *Siphurur* are of the most generalized type. They are long and slender and the three pairs are of equal length. The surfaces are sparsely covered with inconspicuous hairs. The tarsal claw

is long, slender and without teeth. The tibial plate is well developed, consisting of a thick, flattened projection of the tibia, which bears transverse ridges. The attachment of the legs allows free movement and the nymphs are capable of running very swiftly. The middle and hind legs of *Chironomides* are similar to those which have been described, but the first pair has been modified for food gathering and respiration. At the base of the coxa, there is a large tuft of forked gill filaments. From the tibia an elongate flattened spur extends for more than half the length of the tarsus, and along the inner margin of femur, tibia, and tarsus is a regularly arranged row of very long, stiff hairs. When the legs are sharply bent, these hairs, together with the tibial spur form the bottom of the plankton basket already referred to.

In *Cænis*, *Tricorythus* and *Ephemerella* the legs do not lift the bodies at all. Nymphs of *Cænis* and *Tricorythus* clamber upon very uneven surfaces so that the legs do not extend straight out from the body as they do in some of the *Ephemerellas* later noted. The strain of pulling and climbing comes evenly upon every segment of the leg and there is little difference in their size. In both of these genera the tarsal claws are in constant use and are correspondingly well developed. The same evenly distributed development may be seen in the legs of certain *Ephemerellas*, which constantly crawl over mud, dead leaves, and small debris. In others in which there are well established clinging habits (Pl. L, Figs. 39, 43), the fore femora are enormously developed by the constant pulling incident to their position. In these legs the hinder part of the femora is greatly thickened by the muscular development, but the front edge is thin and blade-like and often jaggedly toothed or serrate.

Ephemerinae.

Two stages of modification are shown in the legs of *Potamanthus* and *Ephemera*. In *Potamanthus*, which crawls upon the bottom in a manner similar to the *Heptageninae*, the legs sprawl out from the body in the same way. The tibia is prolonged into a flat spine which overlaps the first third of the tarsus. The structure of this fore leg appears to be the fore-runner of the greater modification shown in the fore legs of *Ephemera*, (Pl. XLIV, Fig. 8), which are perfect digging tools.

V. MODIFICATIONS OF ADULT STRUCTURES.

Reproduction is the sole end of the imago life. Parts of the body which have no function connected with it are reduced or atrophied.

It is probable that, with but few exceptions, May-flies engage in some kind of mating flight. The character of this flight and the time when it occurs vary. The following records show some of these variations. On June 25th a swarm of three or four hundred individuals of *Choroterpes basalis* were swarming over the water of Fall Creek at about four o'clock on a sunny afternoon. Their average rise must have been thirty feet. From the swarm both males and females were captured, but mating was not observed. On June 29th, at 7:30 in the evening, a female *Ephemera varia* was captured from a swarm which was rising and falling in flights of thirty to forty feet. Often they descended to within five feet of the ground. Their dance continued until darkness hid them. Mating flights of *Leptophlebia prapedita* have been seen in the middle of a sunny forenoon, and at two, four and five o'clock of bright afternoons in May and June. None of these rose higher than fifteen feet and two of the swarms did not fly more than six feet above the ground. One entire swarm which was captured contained forty males and one female.

Actual mating has been observed but a few times. The most satisfactory observation was made in May, 1911, upon a swarm of *Baetis*, which were flying near Cascadilla Creek just after a shower. Most of the time they were not flying much above the level of the eye so that they could be clearly seen. Large numbers continually settled on bushes and upon my clothing, and there appeared to be about equal numbers of males and females. Many matings occurred, but in only seven could the positions of the insects be seen at all. The male of one of the couples flew up and attached himself beneath a female, pressed the dorsal side of his head against the ventral side of her thorax and extended his fore-legs upward, in order to clutch her prothorax. The setæ of the female extended straight out posteriorly, but those of the male were pointed forward over his back so that their tips projected between the heads of the two insects. The position of the abdomen could not be clearly seen, but judging from that of the setæ it

must have been recurved in order to insert the penes inside the egg valve. Copulation did not last more than half a minute. When in copula, each pair was borne diagonally downward to the ground, but always separated immediately upon touching it.

So far as known flight is a necessity for copulation and egg-laying in May-flies. The alimentary canal and the legs play a part in flight which is peculiar to this group. It is a well known fact that adult May-flies take no food and that the alimentary canal is inflated with air or gas. Sometime before emergence the nymphs cease to eat and just before it, they push their heads above the surface and appear to be rapidly gulping in air. If dissected at this stage the alimentary canal is found much inflated. It remains thus inflated throughout life. The structure of the alimentary canal of adults was studied by Fritze, '06 and by Sternfeld, '07. Sternfeld found a complicated muscular dilator apparatus in the esophagus. This he concluded to be a pump by which the mid-gut was filled with air and by which its supply could be voluntarily controlled. He did not discover whether any change occurred in the air taken in. No suggestion was made as to when this pump was used, but it is probable that it functions when the canal is first inflated by the nymph and afterward in controlling the specific gravity during flight. This change of the alimentary canal from its normal function to that of a balloon is very important to flight. The lessening of the specific gravity made possible by this modification makes the work of the wings much easier. Since it is more important that adults mate, than that they live a long time, this function of the alimentary canal exceeds the former one in value.



Fig. 1. Legs of male imago of *Hexagenia bilineata*. A, first leg; B, second leg; C, third leg; I, opposite side of legs showing tibial spur.

It has already been noted that adult May-flies use their legs little or none in walking and in many instances the fore legs are not even used for support. In most males the fore legs are enormously lengthened and when the insects are at rest, they are often extended out from the head (Pl. XLIV, Fig. 9). The middle and hind legs brace the body, but they usually lift only the front part, while the abdomen rests upon the supporting surface (Pl. XLIII, Fig. 6). The fore legs are necessary structures in copulation and males of *Palingenia* which have very short legs mate not in mid-air, but close to the surface of streams. (Eaton). The legs of some May-flies have been enormously specialized. The fore-legs of a South American *Campsurus* are very long, (see Fig. 3), while the middle and hind ones are but short stubs. In the fore legs there is a twist in

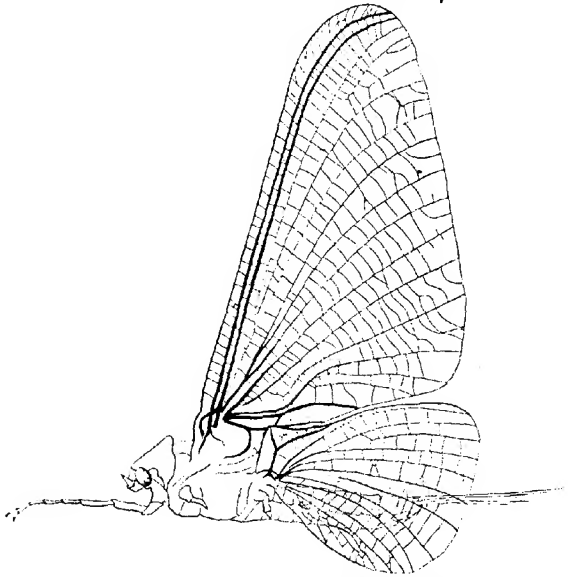


Fig. 2. Male imago *Campsurus* (South America) showing rudimentary middle and hind legs. The setae not represented at full length here, are about three times the length of the body.

the joint which articulates the tarsus with the tibia. This admits the supination of the tarsus and is evidently a modification for clutching the female.

External Genitalia of the Male.

The external genitalia of the male consists of a pair of forceps, jointed except in *Cænis* and *Campsurus*, and two penes, each with a distinct opening. The forceps are incurved appendages of the tenth segment, by which the male grasps the abdomen of the female. The genitalia of *Hexagenia*

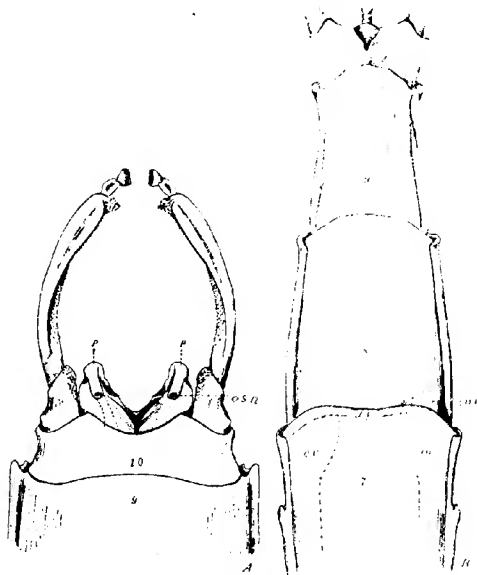


Fig. 3. A, external genitalia of *Hexagenia* sp.? ♂; p, penis; o. s. d., opening of seminal duct; f, forceps. B, ventral view of rear abdomen of *Hexagenia* sp.? ♀, showing ov., outline of oviduct seen through body-wall; e. v., opening of oviduct; e. v., egg-valve; 7, 8, 7th and 8th sternites.

sp.?* are of the simple type. The forceps are three jointed, with a stout basal piece. The two distal segments are concave on the inner surface and tip. These concavities, the flap like extension upon the main segment and the inner surface of the basal piece are thickly covered with small papillæ, which are characteristic of nearly all forceps examined. The roughened surface produced by them probably

*This is a species *Hexagenia recurrata* in manuscript which I have to be published.

helps to hold the female. The penes are the intromittent organs. In *Hexagenia* they consist of two chitinous funnels whose larger ends open inside the body, and whose smaller ends are slender tubes bent down ventrally. Between the penes is a thin chitinous plate, and beneath they are supported by the tenth sternite. In each penis the seminal duct can be clearly traced to its termination at the end of the bent tube.

Of the more complicated condition which exists in most May-flies, the genitalia of *Siphilurus alternatus* is fairly typical (Pl. LI). The forceps are similar to those of *Hexagenia*. Their origin from the ninth sternite is shown in Figures 48 and 49. The penes (P) are wholly hidden from beneath by the tenth sternite, but they are attached only at their bases, and in copulation may be freely projected within the (Fig. 50, EV) egg valve, while the tenth sternite remains outside it. Essentially they consist of the funnels just described in *Hexagenia* with secondary structures added. The larger ends of the funnels open into the body (Fig. 49, A). In Figure 49 the penes are shown in dorsal view, separated off from the dorsal part of the abdomen with the large ends of the funnels exposed (A). The small end of the funnel (B) extends outside the body and turns downward as in *Hexagenia*, but the opening of the seminal duct is enlarged and trumpet-shaped. From the dorsal side only the backs of these trumpets can be seen, but when the penes are completely removed from the ninth sternite and turned with their ventral sides up, one can look directly down into their openings, (Fig. 52, O. S. D.) and the seminal ducts can be traced from the testes directly to them. Lying dorsal and lateral to each seminal tube are two prominent, heavy chitinized processes (Fig. 49). The raised apex of the upper process (C) is pointed toward the middle, that of the lower (D) is pointed outward toward the side and the prominent spines upon each are directed in different directions. If the supposed position of the penes in copulation, be correct, the dorsal or spinose surface of these processes must be in contact with the inner surface of the egg valve (E. V. Fig. 50). When inserted they would thus hook over its soft lip and pull it down, allowing the seminal tubes to discharge their contents at the mouth of the oviducts.

Genitalia of the Female.

In the simple condition each oviduct lies well to the side of the abdomen and opens between the seventh and eighth sternites (Hexagenia). Each opening is perfectly distinct (see dotted line Fig. 3, B) and there is no sign of an open passage or vestibule between the two.

In *Siphylurus alternatus* (Pl. LI, Figs. 53, 55) the lower ends of the oviducts approach each other and open into a common vestibule (C. V.) just inside the egg valve. Opening into this vestibule is a soft membranous sac (S. R.). In fresh specimens this sac shows prominently between the bases of the oviducts (Figs. 53, 55). In figure 55 the sac and oviducts are shown viewed from the inside; the nerve chain has been severed so as to fully expose the sac. In the specimens thus far examined, no spermatozoa have been found within this sac. It is extremely probable, however, that this is a true seminal receptacle, and that this is a specialization which nearly approaches the unpaired opening found in other insects.

VI. THE EGGS.

Under the ordinary conditions of their life a large proportion of May-fly nymphs regularly perish before reaching maturity. A great excess of young must be produced in order to meet this loss and the success of different groups in maintaining their existence becomes more than usually dependent upon the number of eggs produced and the structures which aid in their dispersal and safety during incubation.

In insects whose lives are so brief as these, the eggs are well developed even at emergence, and may then be readily counted, the difference in size between the developed eggs and the egg rudiments being very marked. It is easy, therefore, in mature nymphs, sub-imagoes or imagoes to determine the actual fecundity.

The first count of May-fly eggs was made by Reaumur* to determine the fecundity of some specimens which he captured in his garden. He found egg masses protruding from the abdominal openings, counted the eggs and found about 400 in each mass. His results have been several times quoted by later workers, but no references has been found to any

*Reaumur 1742. T. VI, Mem. XII, p. 495.

other actual determination of the fecundity of May-flies since that time.

In this study the eggs of seventeen May-flies have been counted and examined. They were taken from imagos which had been kept in cages until they showed signs of old age. Usually a count was made of the eggs in several individuals and an average taken. They were examined and counted upon a glass slide in a mixture of water and glycerine which formed a convenient medium in which to manipulate them. The results of the counting are given in a table which follows.

All of the eggs are viscid. When laid in dishes they adhere to the bottom, as do those of *Bætis* to stones. When twigs or algae are introduced, they become attached to them. There are two kinds of structures found upon them; micropylar structures and knob or thread-like extensions of the chorion, both of which are important to the egg; and there is also a variety of chorionic sculpturings which have no apparent significance.

Examples of the more important structures were long ago pointed out. Polar knobs (micropylar structures) were figured by Burmeister '48, and described by Leuckart '55. The latter believed that the knobs were composed of masses of spermatozoa and it remained for Grenacher, '68, to find many stages of them upon developing eggs in the egg-tubes and to point out their true nature. Micropylar structures were also shown in *Palingenia virgo* by Joly, '71 and '76, and in *Bætis sulphurea* by Joly, '76. Grenacher, '68, also pointed out (upon an unnamed May-fly egg) some little threads which were continuous with the chorion and which bore tiny spheres upon the ends. He figured these with remarkable accuracy. Of the eggs here figured, three bear a micropylar apparatus, five have thread-like extensions of the chorion and nearly all are more or less elaborately sculptured.

The eggs of closely related forms may be very different. This is well shown by a comparison of those of *Ephemerella excrucians* and *E. rotunda* (Pl. LIV, Figs, 66, 67). The eggs of *Ephemerella excrucians* are pure white, and slightly dumb-bell shaped, with a distinctly sculptured chorion, but with no micropylar apparatus. Those of *Ephemerella rotunda* are yellowish and oval with a prominent mushroom shaped cap about the micropyle. If examined in the body or when first extruded, two small knobs may be seen upon either side of the egg, near its lower pole. Each knob is attached to the

distal end of a thread-like extension of the chorion, which lies beneath it, tightly coiled like a watch spring. Upon coming in contact with the water these threads spring out like elaters. The little knobs thus extended probably act as floats or anchors for the egg. An even greater difference between the eggs of closely related forms may be seen in the eggs of *Heptagenia interpunctata* (Pl. LIII, Fig. 65) and *Heptagenia pulchella* (Fig. 64). The former has a pure white oval egg without sculpturings or extensions of any kind. The latter is white and slightly rounder with small regularly arranged bosses upon the chorion. At each pole there is a skein of fine bright yellow thread. These skeins are also prominent upon the poles of developing eggs, even in the tips of the egg-tubes. Upon a glass slide they are easily seen with the naked eye and the threads may be pulled out with needles to a length of two or three inches. As soon as the eggs float free in water the skeins begin to unroll and if shaken a little they quickly uncoil altogether and become entangled with any object near them. In nature the eggs are deposited upon the surface of moving water. The threads just described probably wind about sticks or plants and thus anchor the eggs and keep them from being buried with silt during incubation.

Similar extensions of the chorion are found upon the eggs of *Tricorythus allectus* and *Ecdyurus maculipennis*. The eggs of *Tricorythus* (Pl. LII, Fig. 60) are bright green and oval with a prominent shingle-like surface. Upon each side of the egg toward the lower pole are two threads very similar to those of *Ephemerella rotunda*, but without any knobs upon the ends. At the other pole is a prominent smooth yellowish micropylar apparatus. The eggs of *Ecdyurus* (Pl. LIII, Fig. 62) are roundly ovate and pure white. Their entire surface is covered with minute pits and scattered between these are numerous short blunt projections. When the egg is first removed from the body, a small coil of thread may be seen in the depression on the top of each projection. As soon as the egg has been in the water a little while, each coil unwinds with a sudden spring. At the end of each thread is a tiny viscid button.

The eggs of *Leptophlebia* sp.? (Pl. LII, Fig. 58) are elongate ovoid, distinctly brownish and thickly covered with short hairs, so that they look like ciliated protozoans. Those of *Choroterpes basalis* (Pl. LIII, Fig. 63) which are laid in the same

or similar situations have no extensions of the chorion. They are pure white, elongate, with an elaborate design in the sculpturing. The eggs of *Blasturus cupidus* (Pl. LIV, Fig. 68) are slightly flattened and tablet-like. Upon these flattened areas are irregularly scattered pits and bosses which appear shining white in the glycerine and about the longitudinal circumference is a shelf-like extension which bears a large number of strap-shaped pegs. The eggs of *Polymitaecys albus* (Pl. LIV, Fig. 69) are roundly ovate and white. The body of the egg is nearly smooth, but the prominent yellow micropylar apparatus has a distinctly shingle-like surface. The eggs of *Callibaetis fluctuans* and *Chironetes albomaculatus* were perfectly smooth and pure white.

Nymphs of *Hexagenia variabilis* and *Polymitaecys albus* live in the same situations but the eggs of the former are only a little roughened, while *Polymitaecys* has the prominent micropylar apparatus just described. The roughness due to chorionic sculptures may be of some slight service in helping to lodge the eggs, but its significance is probably slight. The extensions of the chorion, on the other hand, are no doubt of much importance in the dispersal and safety of the eggs. The anchors upon *Ephemerella rotunda* and *Tricorythus allectus* hang the eggs upon sticks and stems and prevent them from being buried in the mud; the many viscid threads upon those of *Leptophlebia* and *Ecdyurus maculipennis* accomplish the same result in a different fashion. Those which probably have the most important function are the long threads upon the eggs of *Heptagenia interpunctata*. A number of these were shaken about in water strewn with chara and the threads immediately became closely entangled upon its stems. Eggs thus hung upon stems in natural conditions would be safeguarded and prevented from being buried in the mud.

	Number of egg in both ovaries	Color of egg	Length	Width (Fresh eggs measured in glycerine)
<i>Ameletus ludens</i>	670	Light brown	.276 mm.	.153 mm.
<i>Blasturus cupidus</i>	3700	White	.177 mm.	.093 mm.
<i>Callibaetis fluctuans</i>	500	White		
<i>Chironetes albomaculatus</i>	2500	Pale green	.200 mm.	.138 mm.
<i>Choroterpes basalis</i>		White	.174 mm.	.085 mm.
<i>Ecdyurus maculipennis</i>	1000	White	.170 mm.	.133 mm.
<i>Ephemerella excrucians</i>	1950	White	.200 mm.	.125 mm.
<i>Tricorythus allectus</i>	750	Green	.189 mm.	.122 mm.

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EXPLANATION OF PLATES.

PLATE LXII.

- Fig. 1. Mature nymph of *Blasturus cupidus*.
 Fig. 2. Male imago of *Blasturus cupidus* just after transforming. The male sub-imago skin shows the dark wing-pads.
 Fig. 3. *Anelictus ludens*.
 Fig. 4. Nymph of *Epeorus humeralis*. The hind wing-pads may be seen through the transparent front ones.

PLATE XLIII.

- Fig. 5. Nymphs of *Callibaetis fluctuans*, climbing about in their natural habitat.
 Fig. 6. Male sub-imago of *Callibaetis fluctuans* just emerged.

PLATE XLIV.

- Fig. 7. Half grown nymph of *Potamanthus bettini*.
 Fig. 8. Mature nymph of *Ephemera*.
 Fig. 9. Male imago of *Hexagenia bilineata* showing a posture of the fore leg characteristic of the males of many May-flies.

PLATE XLV.

- Fig. 10. Right gills of *Heptagenia interpanetata*. The first gill is turned with the lower side up and the fimbriate division is fully exposed; in the others it is indicated through the transparent lamella.
 Fig. 11. Right gills of *Epeorus humeralis*, upper surfaces. When in the natural position the spinose border is in contact with the surface upon which the nymph rests.

PLATE XLVI.

- Fig. 12. Right gills of *Isonia fragilis*, upper surface, gills turned backward in natural position.
 Fig. 13. Right gills of *Chironectes albomaculatus*, under surface, gills turned forward.

PLATE XLVII.

- Fig. 14. Mouth parts of *Callibaetis fluctuans*. a, right, and d, left mandibles; b, labrum; c, hypopharynx; e, right maxilla; f, labium.
 Fig. 15. Maxilla of *Tricorythus allectus*.
 Figs. 16 and 19. Right and left mandibles of *Ephemerella lata*.
 Fig. 17. Left maxilla of *Ephemerella serrata*.
 Fig. 18. Left maxilla of *Ephemerella deficiens*.

PLATE XLVIII.

- Figs. 20 and 21. Right and left mandibles of *Tricorythus allectus*.
 Fig. 22. Labium.
 Figs. 23 and 24. Right and left mandibles of *Potamanthus bettini*.

PLATE XLIX.

(Structures of nymph of *Hexagenia*).

- Fig. 25. Maxilla.
 Fig. 26. Second right gill.
 Fig. 27. First right gill.
 Fig. 28. Labrum (La) and Clypeus (Cl), outer aspect.
 Fig. 29. Labrum (La) and Clypeus (Cl), inner aspect, showing the epipharynx lying partly upon the clypeus and partly upon the labrum.
 Fig. 30. Antenna.
 Fig. 31. Right mandible, outer aspect.
 Fig. 32. Right mandible, inner aspect.
 Fig. 33. Hypopharynx, under side, showing lingua and superlinguae.
 Fig. 34. Grinding surface of left molar.
 Fig. 35. Grinding surface of right molar.
 Fig. 36. Left mandible, inner aspect.
 Fig. 37. Left mandible, outer aspect.
 Fig. 38. Labium outer aspect.

PLATE L.

- Fig. 39. Right legs of *Ephemerella lata*.
 Fig. 40. Right fore leg of *Ephemerella serrata*.
 Fig. 41. Right fore leg of *Ephemerella rotunda*.
 Fig. 42. Right leg of *Ephemerella deficiens*.
 Fig. 43. Right fore leg of *Ephemerella tuberculata*.
 Fig. 44. Right fore leg of *Ephemerella cornuta*.

PLATE LI.

(Genitalia of imago of *Siphilurus alternatus*.)

- Fig. 45. Rear abdomen of male, F. forceps, ventral view.
 Fig. 46. Right forceps, showing roughened inner surfaces.
 Fig. 47. Rear Abdomen, dorsal view, showing c. s., caudal setae; pp, penes and 10s, 10th sternite.
 Fig. 48. Rear of abdomen, side view.
 Fig. 49. Dorsal view of penes resting upon the 10th sternite. The white surface, c. e., represents the cut surface of the body wall. The large bases of the penes, a, lying inside the body have been exposed by cutting away the dorsal part of the abdomen.
 Fig. 50. Part of the abdomen of the female. c. v., egg-valve, with the opening of the vestibule directly beneath.
 Fig. 51. Inner view of the 7th and 8th sternites with the oviducts, o. v., and the seminal receptacle turned backward to show the ventral side of the receptacle.
 Fig. 52. Penes removed from the 10th sternite and viewed from the ventral side. o. s. d., opening of seminal duct.
 Fig. 53. Egg valve, common vestibule and outline of receptacle and oviducts, from without.
 Fig. 54. Rear abdomen of female, dorsal view.
 Fig. 55. Dorsal view of dissection of oviducts and vestibule. The top of the vestibule has been cut away and pulled off with the 7th sternite, so as to expose the inner surface of the common vestibule, c. v., and seminal receptacle, s. r.
 Fig. 56. Rear abdomen, female, ventral view.
 Fig. 57. Rear abdomen of female, side view, c. v., egg valve.

PLATE LII.

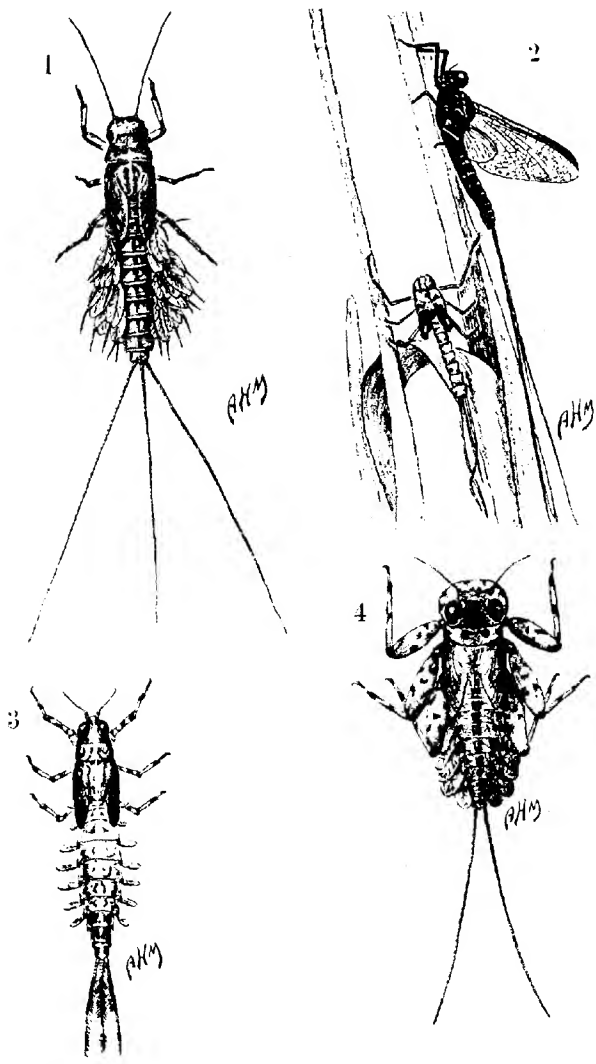
- Fig. 58. Egg of *Leptophlebia*.
 Fig. 59. Egg of *Ameletus ludens*.
 Fig. 60. Egg of *Tricorythus allectus*.
 Fig. 61. Egg of *Chironetes albomanicatus*.

PLATE LIII.

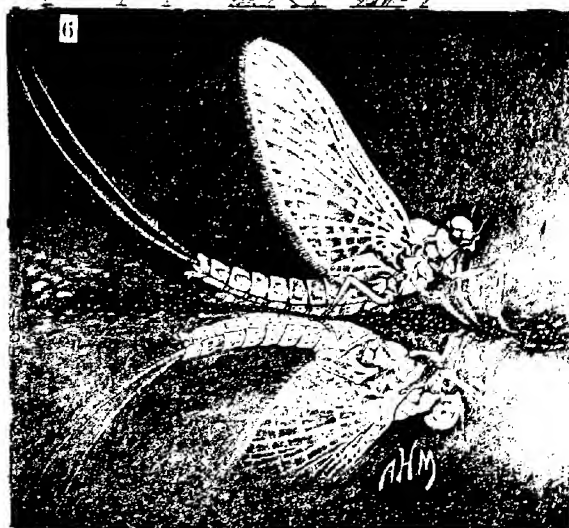
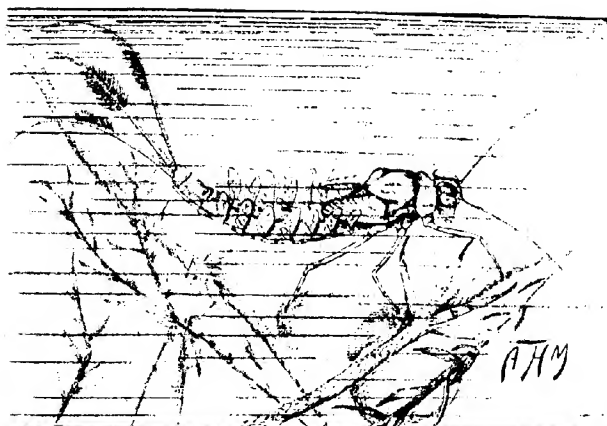
- Fig. 62. Egg of *Ecdyurus maculipennis*.
 Fig. 63. Egg of *Choroterpes basalis*.
 Fig. 64. Egg of *Heptagenia pulchella*.
 Fig. 65. Egg of *Heptagenia interpunctata*. Needham.

PLATE LIV.

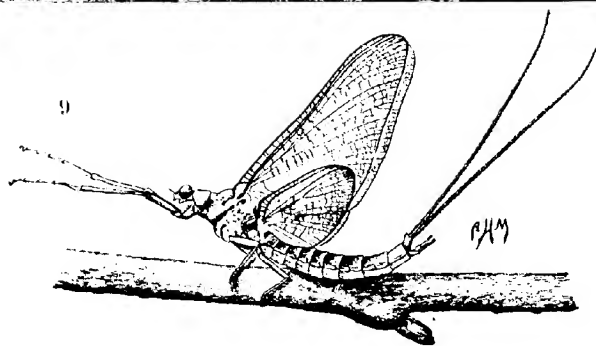
- Fig. 66. Egg of *Ephemerella rotunda*.
 Fig. 67. Egg of *Ephemerella exarciens*.
 Fig. 68. Egg of *Blasturus cupidus*.
 Fig. 69. Egg of *Polymitarcys albus*.
 Fig. 70. Egg of *Siphilurus alternatus*.

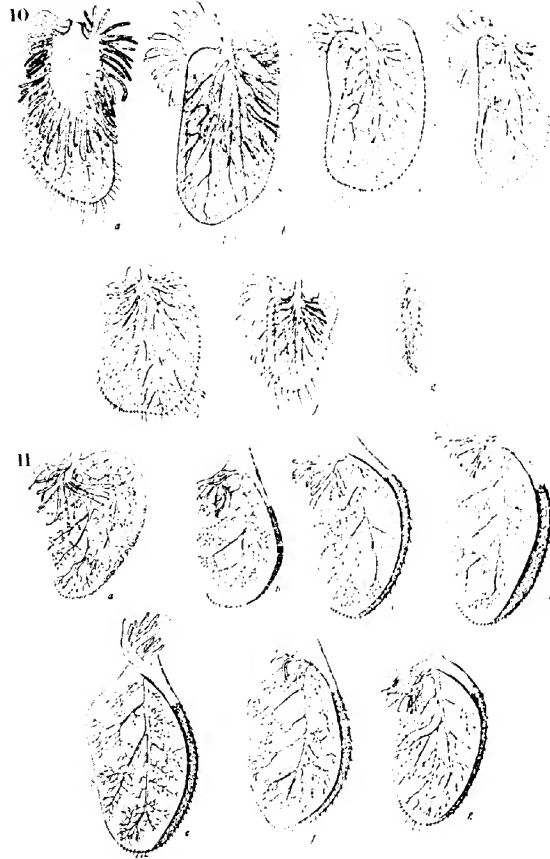


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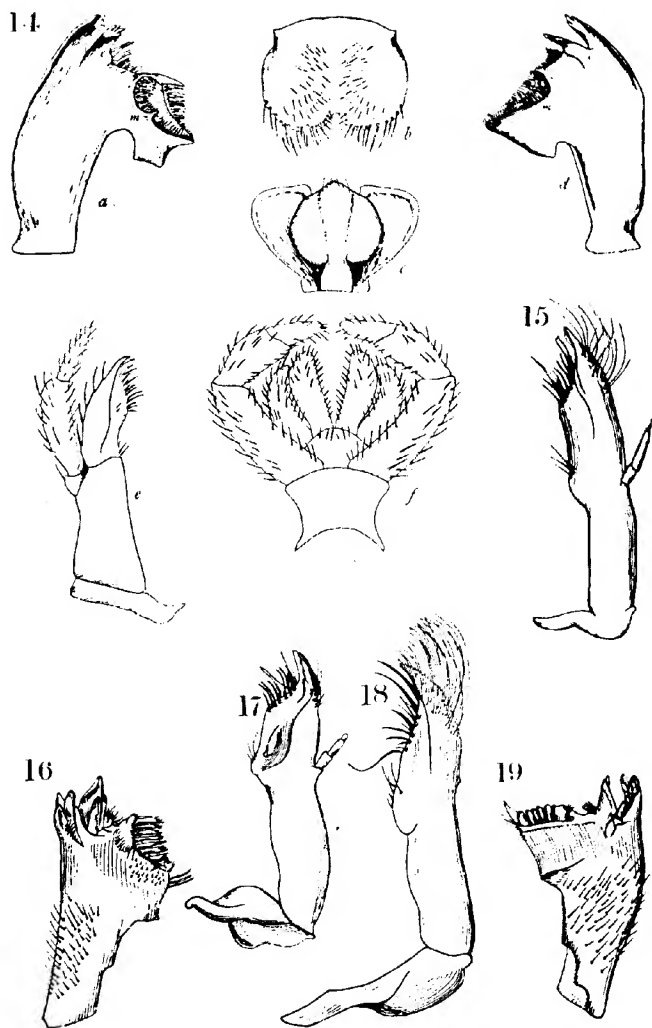


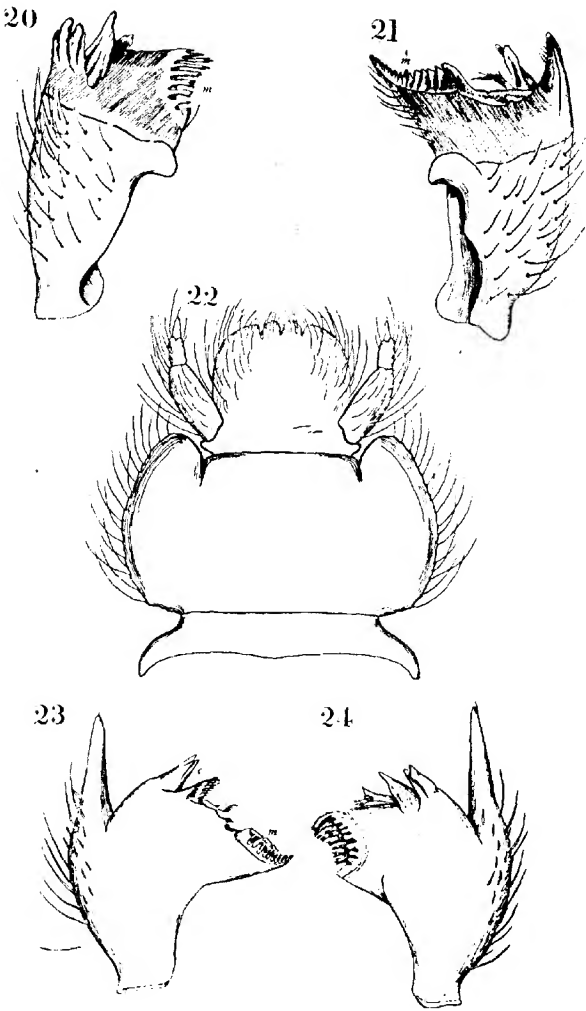
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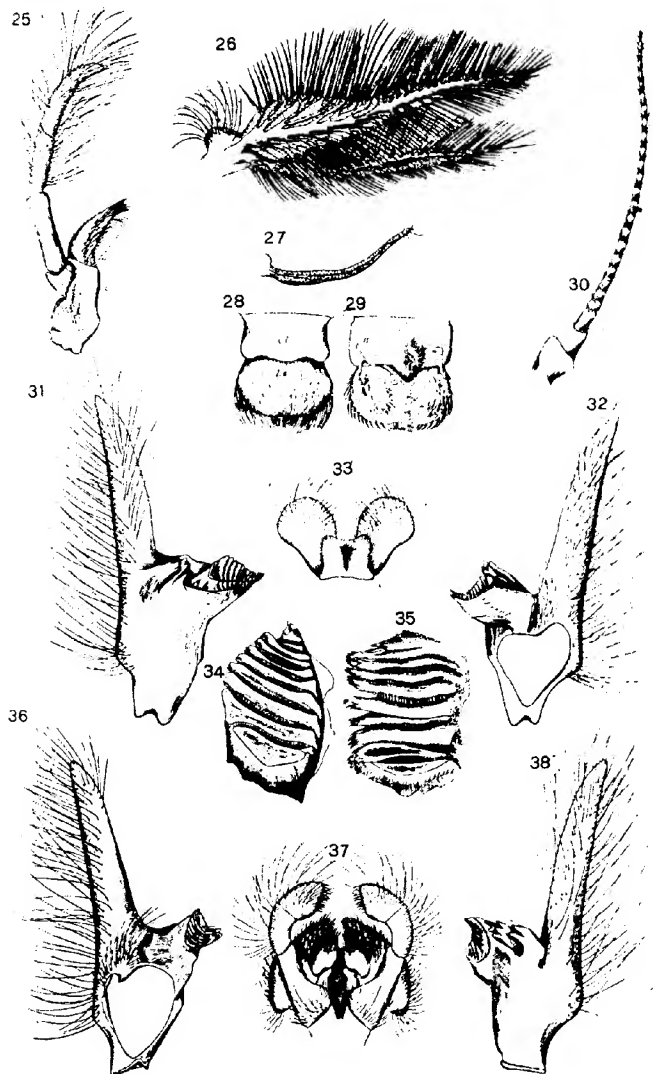


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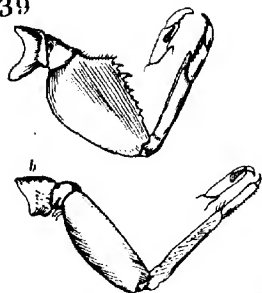




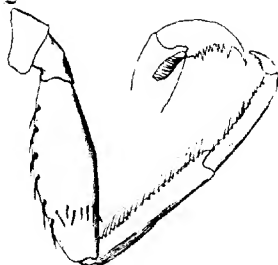




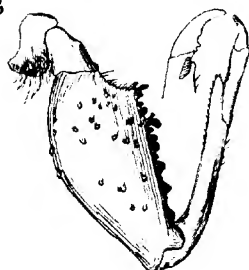
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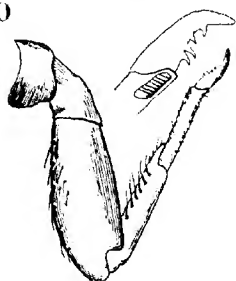
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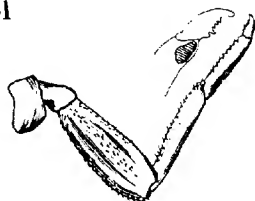
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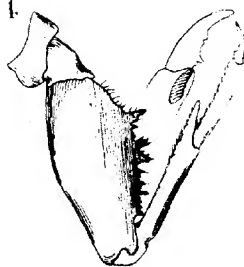
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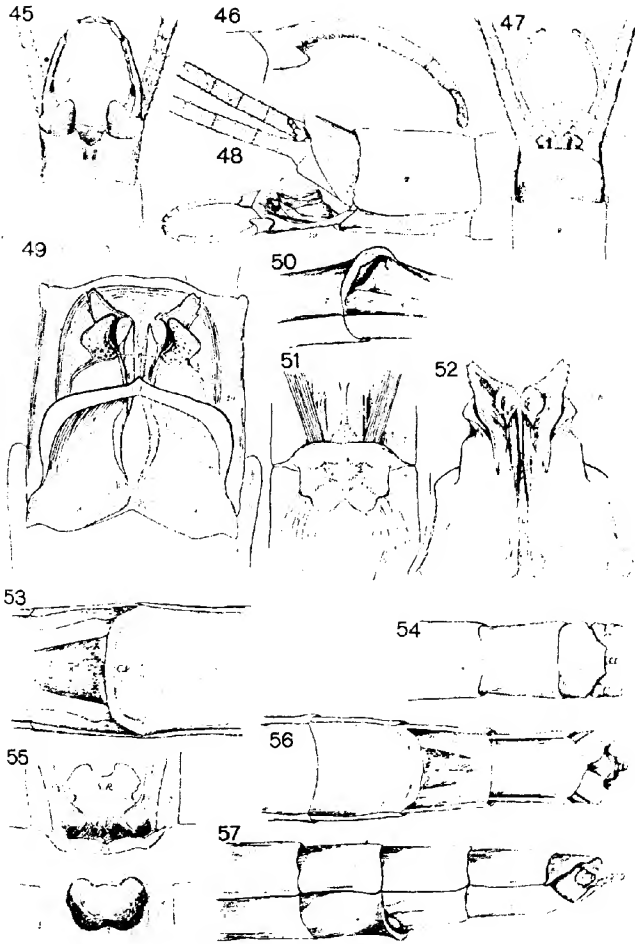


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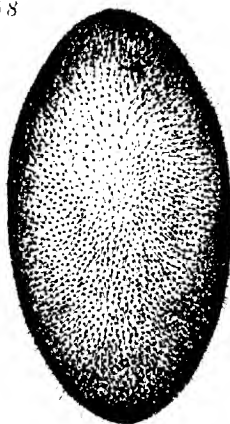


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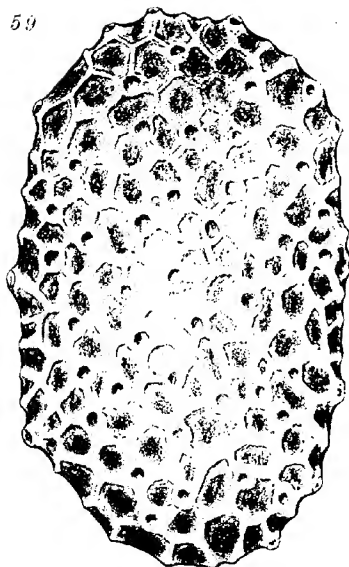




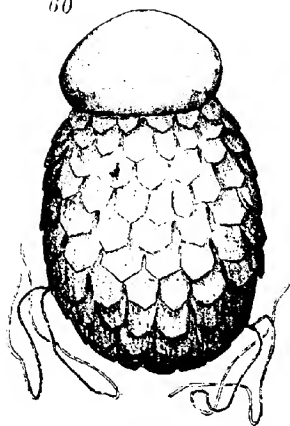
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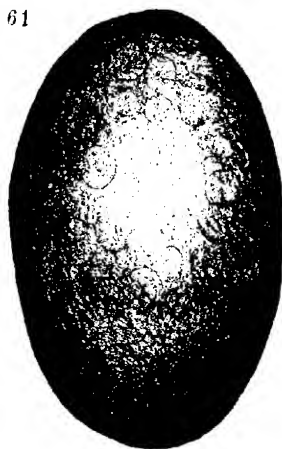
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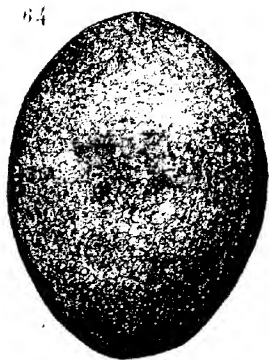
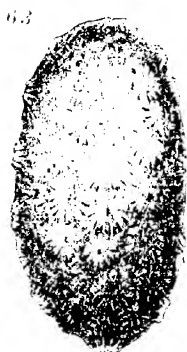
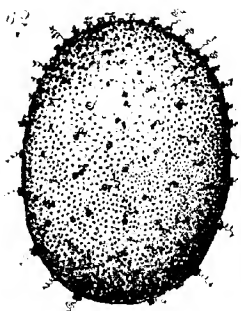


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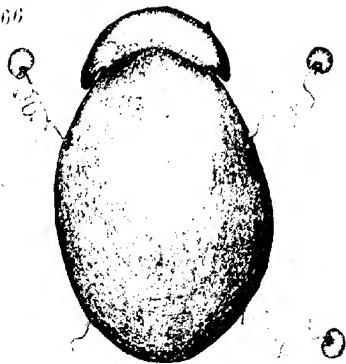




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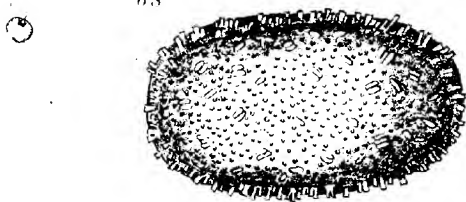
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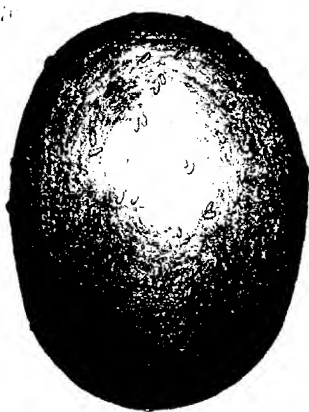
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THE EXTERNAL ANATOMY OF THE SQUASH BUG,
ANASA TRISTIS DE G.*

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INTRODUCTION

In writing this article the chief aim is to endeavor to supply a reference work on the external morphological characters of a typical Heteropterous insect. For this reason the common squash bug has been selected as it is widely distributed, well known as a pest, and is readily obtainable for study.

In order to make the paper as complete as possible the morphologists' and systematists' terms have both been used, except in referring to the wing venation (the systematists' terms being lacking in the fore-wing and the morphologists' in the hind wing).

At this point I wish to express my gratitude to Dr. H. T. Fernald and Dr. G. C. Crampton for their many helpful suggestions and assistance in preparing this paper.

ANATOMY

Head

The sclerites of the head capsule of the squash bug are solidly fused together making it impossible to do more than to describe the general regions of which the head is composed. Of these the occiput (occ), (Pl. LV, f. 1.) lies behind the ocelli (oc) and forms the posterior portion of the head surrounding the occipital foramen. It is marked off by a shallow transverse groove, from

* Contribution from the Entomological Laboratory, Massachusetts Agricultural College.

the vertex. The vertex or cranium (ec) comprises the dorsal region in front of the occiput and bears the ocelli. This area is not marked off from the frons (f), which lies above and between the bases of the antennae (ant). The anterior margin of the frons is united with the base of the clypeus or tylus (c).

Below and on either side of the compound eyes (e) lie the genæ (g) while the ventral posterior portion of the head capsule forms the basal plate or gula (gu). The clypeus, as has been previously stated, is fused at its base with the frons, and at this point is narrow, but as it curves forward and downward it widens at its tip to form the base of attachment for the labrum (lbr) from which it is separated by a narrow membranous ring.

The labrum is an elongate triangular sclerite. Its anterior surface is convex, while its posterior surface is flat and contains a groove which lies above the groove on the basal half of the anterior surface of the labium (lab).

On either side of the clypeus is a narrow prolongation of the frons called the fulcrum, jugum or zygum (fr). The fulcræ lie close to the lateral walls of the clypeus, hiding them, but are not united with them except at their bases, where they fuse with the head capsule. The fulcrum is shorter than the clypeus, its anterior margin lying behind the swelling of the tip of the clypeus. Its ventral margin extends to the base of the antenna where it fuses with the base of the maxillary laminae (ml).

The maxillary laminae or gena postica lie below the base of the antennae. Their bases are fused with the genæ and their ventral margins are united with the bucculæ (bu), which are chitinous plates projecting from the anterior ventral side of the head on either side of the base of the labium. The bucculae serve to protect the posterior membranous portion of the base of the labium.

The rostrum, vagina or labium (lab) articulates with the anterior ventral region of the head between the bucculæ and is made up of four segments, the terminal segment at its tip bearing numerous sensory organs. The labium contains, as stated above, a dorsal groove in which lie the setæ (s). The edges of the groove, distal to the overlying labrum, overlap, forming a closed tube, thus giving the enclosed setæ more support (Pl. LVI, f. 8 s.). At its basal end the groove becomes very shallow; the labium becomes filled with muscles, tracheæ and nerves, and the setæ in this portion of the labium gradually come to lie

within the labrum, whose edges meet beneath and confine the setæ (Pl. LVI, f. 8 s. and Pl. LVI, fs. 21-24's). They then pass back through the articulating membrane, which lies between the labrum and clypeus, and between the lateral walls of the clypeus. The walls of the clypeus at its tip, turn under, and their edges interlock forming a narrow pair of supporting lobes above which the setæ pass. Upon emerging from these lobes the maxillary setæ (m) spread apart to receive the tip of the pharynx and the canal from the salivary pump, both of which enter the setæ at this point.

The setæ represent the mandibles (md) and the maxillæ (mx). The maxillæ are fluted and interlocked so as to form two tubes, these being the upper or suction canal, and the lower or salivary canal (Pl. LV, f. 2). The mandibles are slightly shorter than the maxillæ and their tips are barbed. Their function is that of piercing the plant tissue and holding the setæ in place, while the tips of the maxillæ, which are acute and fluted, probe the plant tissues, take up the plant juices, and eject the saliva. The setæ, as stated, pass back into the head capsule and separate at their junction with the pharynx, going to either side of it. Their bases widening out form points of attachment for the controlling muscles.

The antennæ (ant) are composed of six segments. The third and fifth are ring joints (Pl. LVII, f. 16, r.), or reduced segments; therefore the antenna as a whole appears to be composed of only four segments. The fifth segment, or second ring joint, allows great freedom of motion to the terminal segment. The second and fourth segments are long and slender. The proximal segment is called the scape or radícula (sac). It is large and has a stalked base, which enlarges at its connection with the head to form a universal joint. The terminal segment is spindle shaped and covered with numerous sensory hairs. The other segments possess sensory hairs, but not as specialized as those of the terminal segment.

The compound eyes (e) are large and composed of many facets, and project prominently from the head. The ocelli are two in number.

The posterior portion of the head or the collum is set into the collar of the prothorax and is joined to it by a membranous neck.

Thorax

Prothorax.—The prothorax is a large chitinous segment whose sclerites are solidly fused together, with the exception of the episternum and epimeron which are separated for a short distance by the coxal cleft (b).

The notum (no) overlaps the prescutum, scutum, and a portion of the scutellum of the mesothorax dorsally; and the pleural region projects over a portion of the anterior part of the mesothorax laterally (Pl. LV, f. 1 and 4). The tergum or notum is of one piece, its sclerites being indistinguishably fused together. Its anterior portion is more or less irregular due to the attachments of the muscles of the fore leg to its inner surface. The union of the notum and pleuron forms a well defined ridge.

The Pleuron (pl) is divided, as stated above, by the coxal cleft into the epimeron (epm) and episternum (eps). The cleft extends only a short distance into the pleuron terminating in a groove. Above this the pleuron bulges out forming a larger cavity for the expanding muscles of the fore leg. This region of the pleuron is called the omium (om).

The sternum (st) is a small area lying between, and anterior to the coxal cavities, and is indistinguishably fused with the pleuron. The portion of the sternum projecting backward between the coxal cavities is called the muero (mu). The anterior portions of the coxal cavities are formed by the inner surfaces of the epimeron, episternum, and the sternum; and are closed posteriorly by the extensions of the prothorax epimeron and sternum, together with the anterior portion of the mesosternum.

The legs show the usual five divisions into the coxa (co), trochanter or fulcrum (fr), femur (fe), tibia (t), and tarsus (ta) (Pl. LVI, f. 13). Since the fore legs are typical, although they are proportionately smaller, one description will be sufficient. At the base of the coxa hidden within the coxal cavity is a narrow plate called the trochantin (Pl. II, f. 9 ti). The coxa is a large swollen segment lying largely within the coxal cavity and is freely movable. The trochanter or fulcrum is a small segment which forms a ginglymus articulation with the coxa and is obliquely joined to the side of the femur. The femur is long and more or less spindle shaped; the tibia articulates with it by a ginglymus joint and is long and slender. The tarsus is composed of three segments. The first segment is called

the Metatarsus (meta), and the terminal segment the ungula (u). This bears divergent claws called unguicula (ua) beneath each of which lies a pulvillus (pu) modified to form a concave adhesive pad (Pl. LV, f. 3).

Mesothorax.—The mesothorax is attached to the prothorax by the intersegmental membrane, and the two segments are easily separated, thus uncovering the anterior area of the scutellum and the scutum and prescutum. The covered areas, or the scutum and prescutum, are also called the dorsulum.

The scutum (sc) is divided longitudinally by a wide median furrow. In the scutum, on either side of the median furrow are two irregular longitudinal impressed lines (d), which are possibly homologous with the parapsidal furrows of the Hymenoptera. If this be the case, then the area lying between the two last mentioned impressed lines would be the prescutum (psc), while the areas lateral to the lines would be the scutum (Pl. LVI, f. 10).

Lying posterior to the scutum and separated from it by a transverse ridge is the scutellum (set), which is triangular in outline and projects posteriorly over the metathorax and the first abdominal segment. On the lateral edge of the scutellum is a ridge called the frenum (fm) (Pl. LVI, f. 10).

The postcutellum (psct) of the mesothorax forms the anterior wall of the phragma (phr) situated between the meso and the metathorax, while the prescutum (psc) of the metathorax forms its posterior wall. Both of these sclerites are only slightly visible externally (Pl. LVI, f. 10).

The fore wings are characteristic of the suborder Heteroptera being partly membranous and partly coriaceous. Their bases articulate with the mesonotum by means of small chitinous plates called ossicula or axillaries.

The membranous and coriaceous portions of the fore wings are separated by a more or less broken oblique suture called the sutura membranæ (s-m). The coriaceous portion is marked off into three areas by two longitudinal sutures (Pl. LVIII, f. 19). These areas are as follows: the clavus (cl), which lies next to the mesoscutellum when the wings are in repose; the corium (cr) which lies between the two sutures; and the embolium or costal area (em), which lies beyond the second suture. The first suture or the one which marks off the clavus is called the sutura clavi or anal furrow (s-c). The suture separating the corium from

the embolium is called the median furrow (m-f). The margin of the clavus, which when the wing is at rest lies along the lateral edge of the mesoscutellum, is called the margo scutellaris (m-s), while the margin of the clavus beyond the tip of the mesoscutellum, is called the commissura (cm).

There are three angles in the coriaceous portion, used in classification. These are as follows: the internal angle, angulus internus (a-i) formed by the meeting of the sutura membrane and the sutura clavi; the angulus clavi (a-c), which lies between the sutura clavi and the commissura; and the angulus scutellaris (a-s), which is formed by the meeting of the commissura and the margo scutellaris.

The coriaceous portion of the wing has an inconspicuous venation to which the following names have been given. The costa (ca) is the longest vein, lying nearly parallel to the costal margin of the wing. The subcosta (sca) and radius (ra) lie posterior to the costa, their basal halves being coalesced. Behind or posterior to the coalesced subcosta and radius, lies the median vein (me) connected by a short cross vein (r-m) near its tip with the radial sector. The cubitus (cu) lies within the clavus; and the first anal vein (a) lies along the margo scutellaris except at its base where it extends into the clavus.

The anterior part of the mesopleuron is hidden under the prothorax. It is partially divided into two sclerites, the epimeron and the episternum, by the coxal cleft over the insertion of the mesocoxa. A third plate which is a marked off portion of the epimeron lies at the base of the fore wing and is wholly hidden by the prothorax. It is called the basalar plate (ba). A chitinous plate called the prealar bridge (o) connects the pleuron and the scutum near the juncture of the mesothorax with the prothorax. Below this plate lies the mesothoracic spiracle (sp) in the intersegmental membrane between the meso- and prothorax. Posterior to the basalar plate is an invaginated triangular apodeme (ap) whose position is indicated externally by a cavity. A continuation of one of the angles of this cavity marks off part of the dorsal border of the pleuron causing it to appear as a sclerite. A membranous area extends from the base of the fore wing to the prealar bridge, and separates the scutum from the pleuron and its plates.

The sternum is of one piece solidly fused with the episternum. The coxal cavities are formed by the inner surfaces of the

epimeron, episternum and sternum anteriorly, and posteriorly by the anterior margin of the metasternum and metaposternum.

Metathorax.—The notum of the metathorax is well developed and is composed of three sclerites. The prescutum (pse), which has already been described, forms the posterior wall of the phragma between the meso and metathorax, and in its normal position is only slightly visible from the exterior. The scutum (sc) and scutellum (set) are fused and the visible portions appear as an elongate triangular sclerite on either side of the mesoscutellum which hides the middle portion. The postscutellum (psct) lies behind this sclerite and is fused with it, its central portion being hidden beneath the projecting mesoscutellum.

The pleuron (pl) is partially divided by the coxal cleft into a large epimeron or pleurum and a very small episternum, the latter being indistinguishably fused with the sternum. At the upper end of the cleft lie the two light yellow scent glands (sg) separated by a pit which extends into the body cavity and into which flows the fluid secreted by the glands. Lying above the scent glands and hidden in the folds between the meta and mesothorax is the metathoracic spiracle. On either side of the dorsal margin of the metapleuron is a longitudinal grooved area called the cenchrus (Pl. LV, f. 4, cc and Pl. LVI, f. 10, cc), in which there lies a ridge, located on the ventral side of the costal margin of the fore wing.

The hind wings or alae (hwa) are joined to the metathorax although their bases appear to lie mostly above the mesopleuron when viewed laterally. Their bases articulate with the fused scutum and scutellum, whose posterior margin is continuous with the posterior margin of the wing. The alae articulate with the metanotum by means of numerous small chitinous plates called ossicula or axillaries.

The wing is wholly membranous and distinctly veined. The venation given is the purely systematic one. The costa primaria (ca-p) is the large vein lying just posterior to and parallel with the costal margin in the basal half of the wing (Pl. LVIII, f. 20). The costa subtensa (ca-s) lies below the costa primaria and is more or less parallel with it. Near the distal end of the costa subtensa is a short incomplete transverse vein which nearly reaches the costa primaria. This is called the Hamus (ha). The distal ends of the costa primaria and subtensa are connected

by a short vein, the costa connectens (ca-c). From the union of the costa primaria and costa connectens the costa apicalis (ca-a) extends outward toward the apex of the wing. Behind the costa apicalis and nearly parallel with it lies an unnamed vein which is usually unbranched although in an abnormal specimen a short branch vein has been noticed arising from it and extending outward between it and the costa apicalis. From the union of the costa subtensa and the costa connectens extends the costa decurrens (ca-d), a strongly curved vein. Behind the costa decurrens lie two nearly straight, short veins called the costa lineatæ (ca-l). Behind the costa lineatæ lie three veins in the anal area, the costa radiantes (ca-r). The first is not attached to the base of the wing while the second and third are so attached.

Abdomen

The abdomen is broadly joined to the thorax and its anterior portion is overlapped by the metathorax to such an extent that the spiracle situated in the pleural region of the first abdominal segment is completely hidden beneath the metapleuron. The first six segments of both male and female bear a pair of spiracles.

The first four and part of the fifth segments of the abdomen show clearly the marking off into four typical regions. The notum (no) is the flat, black, dorsal portion on which the wings rest. The pleural areas or connexivum which form the sides of the trough in which the wings lie when at rest are situated one on either side of the dorsal region, and extend to the prominent lateral edges of the abdomen. The sternal area is that forming the ventral and lateral portions of the abdomen. The spiracles (sp) are located near the dorsal edges of the sternum. The sclerites of the posterior portion of the fifth segment, and of the segments following, are more or less closely fused together and are specialized for reproduction in both males and females.

There are nine segments in the abdomen of the male. The seventh is not visible under normal conditions, but together with a large part of the eighth segment, is retracted within the sixth segment. The seventh segment is highly specialized for this purpose, being merely a collar of chitin which telescopes over the base of the eighth segment. The eighth or genital segment is also highly specialized, its sclerites being solidly

fused together, except dorsally where the chitin is almost membranous just anterior to the rectal cauda (rc). Its shape is also greatly modified. The dorsal aspect presents a large pit or cavity, above which lies the rectal cauda and the genitalia. The chitinized tip of the rectal cauda is the much modified ninth segment. The rectal cauda projects posteriorly from the dorsal wall of the eighth segment, which is called the pygidium (pg). The basal half of the rectal cauda is membranous above and below, but slightly chitinous laterally. Its posterior half, which lies folded and hidden within the basal portion, is membranous except the tips which are chitinized, and open and close as do the edges of a purse. Beneath the basal portion of the rectal cauda lies the œdeagus, those chitinized portions of the male genital organs through which pass the membranous structures connected with the ejaculatory duct. Posterior to the œdeagus lie two movable appendages or styli (la). The ventral portion of the eighth segment which bears internally the lateral appendages and contains the œdeagus is called the hypopygium (pp).

Dorsally, the abdomen of the female presents ten segments. The tenth, which forms the chitinous lips of the rectal cauda, is hidden within the ninth, except when extruded, and is widely separated from the ninth by the membranous rectal cauda. The dorsal portion of the ninth segment is called the pygidium. Ventrally, the ten segments are not so easily recognizable, especially when the abdomen is extended, as the segments are variously modified for protective and reproductive purposes. Attached to the insides of the dorsal and ventral portions of the eighth abdominal segment are two pairs of chitinous appendages, the lateral appendages or styli, armed with stiff spines or hairs. These lie above and protect the soft portions of the genitalia when in repose. These appendages may function as claspers in copulation, but actual observation of this function will be necessary to determine this point. The ventral portion of the eighth abdominal segment is called the hypopygium.

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LETTERING OF FIGURES.

Numbers 1-10 denote number of the segment. Subscripts 1, 2, 3, pro-, meso-, metathorax, respectively.	e	eyes.
a	em	embolium.
a-c	epm	epimeron; mesothoracic epm = scapula; metathoracic epm = pleurum.
a-i	eps	episternum.
a-s	f	frons.
ab	fe	femur.
ant	fm	frenum.
ap	fr	fulcrum, jugum or zygum.
b	fw	fore wing.
ba	g	gula.
be	hw	hind wing, ala.
bu	la	lateral appendages, styli.
c	lab	labium, rostrum, vagina.
ca	lbr	labrum.
ca-a	m	maxillary setæ.
ca-c	m-f	median furrow.
ca-d	m-s	margo scutellaris.
ca-l	md	mandibular setæ.
ca-p	me	median vein.
ca-r	ml	maxillary luninæ, gena postica.
ca-s	mta	metatarsus.
ce	mu	macro.
cl	n	salivary canal.
cm	no	notum.
co	o	prealar bridge.
cr	oc	ocelli.
cu	occ	occiput.
d	om	omium.
d		parapsidal furrows.

s	suction canal.	s-m	sutura membrane.
sg	pygidium.	sa	scapæ.
phr	phragma.	sc	scutum.
pl	pleuron; abdominal pleuron = connexivum.	scu	subcosta.
tp	Hypopygium.	set	scutellum.
psc	prescutum.	sg	secal glands.
pset	postscutellum.	sp	spiracles, stigmata.
pt	pulvillus.	st	sternum.
r	ring joints.	t	tibia.
r-m	connecting vein between radius and me.	ta	tarsus.
ra	radius.	ti	trochantin.
re	rectal cauda.	tr	trochanter, fulcrum.
s	setæ.	u	ungula.
sc	sutura clavi, anal furrow.	ua	unguicula.
		v	vertex, cranium.

EXPLANATION OF PLATES.

PLATE LV.

- Fig. 1. Lateral view of head, thorax and first segments of the abdomen.
 Fig. 2. Cross section of the mandibular and maxillary setæ.
 Fig. 3. Lateral view of a tarsal claw and the adhesive pad or modified pulvillus lying beneath it.
 Fig. 4. Lateral view of the meso- and metathorax, as seen looking obliquely backward, the prothorax being removed and the wings raised and the abdomen abnormally extended to show the spiracle on the first segment.
 Fig. 5. Dorsal view of the abdomen. The female genitalia are not extended.

PLATE LVI.

- Fig. 6. Maxillary setæ showing fluted and piercing tips; (see fig. 2 cross section of maxillary setæ).
 Fig. 7. Mandibular setæ showing barbed and piercing tips.
 Fig. 8. Cross section of labium at the tip showing how the setæ are supported.
 Fig. 9. Coxa and trochantin.
 Fig. 10. Dorsal view of the meso- and metathorax with the wings extended.
 Fig. 11. Lateral view of the male genitalia extended.
 Fig. 12. Ventral view of the male genitalia normally retracted.
 Fig. 13. Typical leg.
 Fig. 14. Lateral view of female genitalia normally retracted.

PLATE LVII.

- Fig. 15. Dorsal view of male genitalia extended.
 Fig. 16. Antenna.
 Fig. 17. Ventral view of the insect showing female genitalia.
 Fig. 18. Lateral view of female genitalia extended.

PLATE LVIII.

- Fig. 19. Fore wing.
 Fig. 20. Hind wing.
 Figs. 21-24. More or less diagrammatic.
 Fig. 21. Cross section of second segment of the labium, showing the position of the setæ.
 Fig. 22. Cross section at the tip of the first segment of the labium, showing the position of the setæ.
 Fig. 23. Cross section at about the middle of the first segment of the labium, showing the position of the setæ.
 Fig. 24. Cross section at the base of the labrum, showing how the setæ are supported.

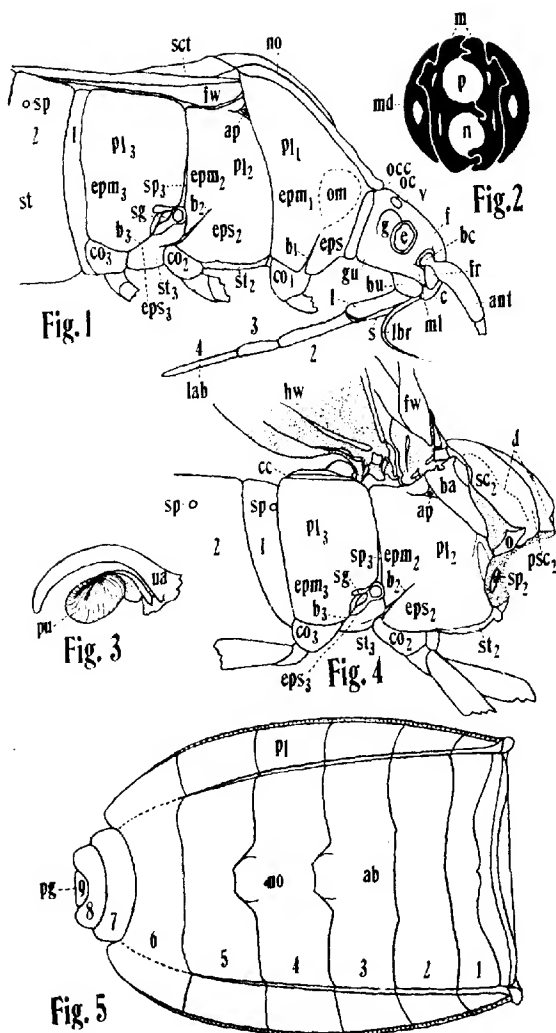




Fig. 6



Fig. 7

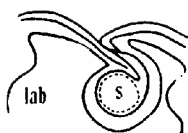


Fig. 8

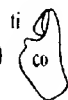


Fig. 9

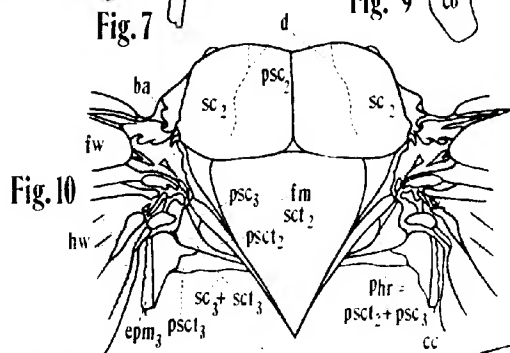


Fig. 10



Fig. 11

Fig. 12

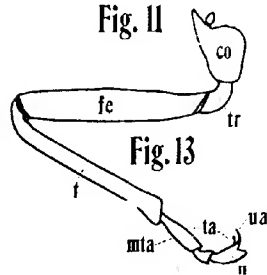


Fig. 13

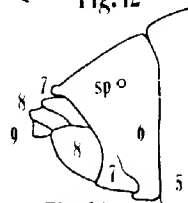
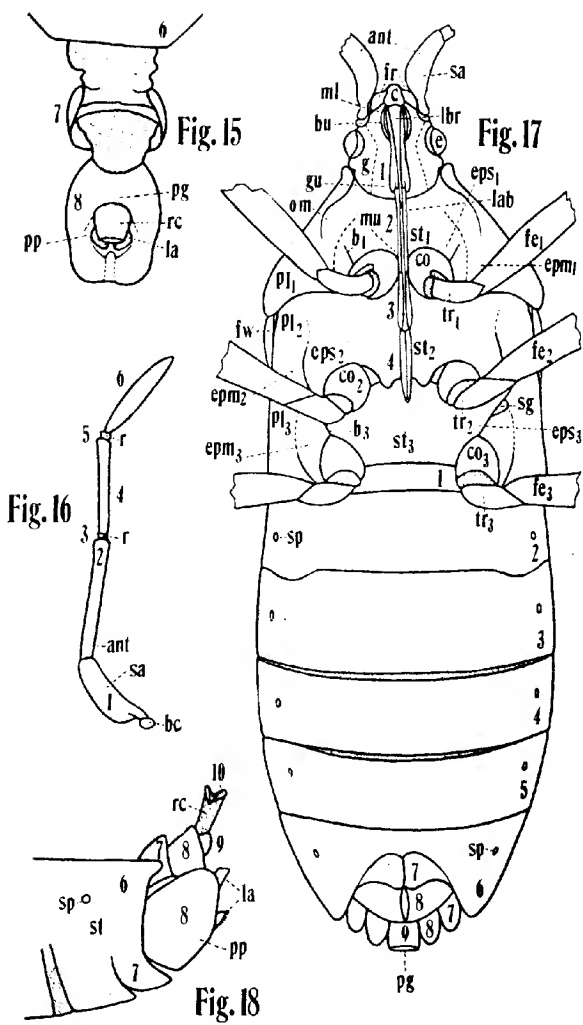


Fig. 14



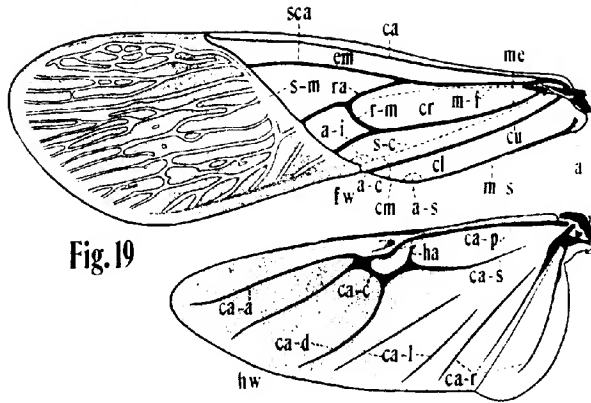


Fig.19

Fig.20

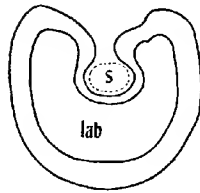


Fig.21

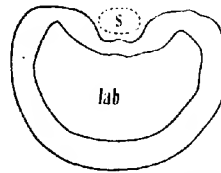


Fig.23

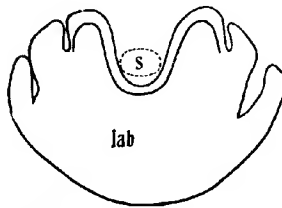


Fig.22

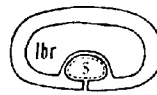


Fig.24

THE DIPTERAN FAUNA OF BERMUDA.

By CHARLES W. JOHNSON.

Since publishing a list of the Diptera of Bermuda in 1901, *Psyche*, vol. XI, pp. 76-80), I have received a number of specimens from Professor Trevor Kincaid, collected in the summer of 1905, and from Mr. Frank Morton Jones, collected December, 1908-May, 1909, and Dr. Reynold A. Spaeth, collected in the summer of 1910. The material thus obtained at various seasons of the year together with the notes kindly furnished by Mr. Jones, greatly increase our knowledge of the Diptera of the Islands. The study of this material has brought out many interesting points in distribution, some of the species derived from the mainland having become either slightly or decidedly differentiated.

The previous list contained about fifty species. Little of the data has been repeated, although all of the species are included in the following list, which contains about ninety-five species.

TIPULIDÆ.

Tipula costalis Say. "This fly was abundant at Paget Marsh in February and March, but seemed to completely disappear later." (F. M. Jones).

Dicranomyia liberta Osten Sacken. July 7 at light, (Kincaid), Feb. 14 (F. M. Jones).

Gonomyia (Leiponeura) pleuralis Will. This seems to be the most common Tipulid and the one previously recorded as *Dicranomyia distans*, Osten Sacken. It was taken by Professor Kincaid, July 5 and 20, and by Mr. F. M. Jones, Feb. 19 and May 6 and 8.

Limnophila insularis sp. nov. Fig. 2.

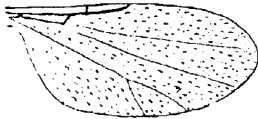


Fig. 1.



Fig. 2.

* This species has a general resemblance to *L. recondita* Osten Sacken. The antennæ in both sexes are of equal length, light yellow, flagellum dark brown, the verticilli much shorter than in *L. recondita*. Head reddish, covered with a greyish bloom. Thorax shining brown, legs dull yellow with a greyish bloom. Abdomen dark brown.

genitalia yellow. Halteres yellow, knob somewhat infuscated. Legs yellowish, tarsi brownish toward the ends. The wings are noticeably shorter and broader toward the base than in *L. recondita*, the pterofurca is shorter and the marginal cross vein at the middle of the anterior branch of the second vein is close to the tip of the first longitudinal vein. Length, ♂ 6mm. ♀ 7mm.

Two specimens. ♂, March 10, ♀, May 1, 1909, (F. M. Jones).

PSYCHODIDAE.

Psychoda alternata Say. Nine specimens were received from Mr. Jones. These were collected by Mr. Mowbray, May 15.

Psychoda sp. A larger species was collected by Prof. Kincaid and retained by him for study.

CHIRONOMIDAE.

Chironomus cristatus Fabricius. July 26 (Kincaid); Paget Marsh, March 10, (F. M. Jones); near Hamilton, June 26 (Spaeth).

Orthocladius sp. July 15 (Kincaid).

Metriocnemus knabi Coquillett. Eight specimens, February 1 (F. M. Jones).

Ceratopogon fur sp. nov. Fig. 1.

Female: Head black, proboscis brown, palpi black, antennae black, covered with a thick grayish pubescence, apparently with fourteen joints. Thorax black, subshining, hairs grayish, scutellum dark brown, abdomen dull black, thickly covered with grayish hairs. Legs brown, tip of the tarsi and claws black, posterior metatarsi as long as the following joints. Halteres black, the stalks short and thick, the knobs proportionately large. Wings smoky, strongly pubescent, venation as shown in the figure, the third and fourth longitudinal veins obsolete toward the basal portion of the wing. Length, 1mm.

Two species, Warwick Marshes, April 16 (F. M. Jones).

The two specimens were attached to a small dragon fly, an Agrionid, with the mouth parts extended into the sutures near the base of the wings apparently in the act of biting. This is the second time that the writer has seen a *Ceratopogon* attached to an insect. The first example was also taken by Mr. Jones, the flies being attached to the wings of a *Chrysopa*. This specimen was loaned to Dr. E. P. Felt in connection with his studies of the Cecidomyiidae, as a species of the latter family has been recorded by Mrs. Annie T. Slosser as also attaching itself to the wings of a *Chrysopa*. (Ent. News, VII, 238, 1896).

Ceratopogon sp. July 12 and 29 (Kincaid).

CULICIDAE.

Stegomyia calopus Meigen, (*Stegomyia fasciatus* Fabr.) The "yellow fever mosquito," June 25-29 (Kincaid); Jan. 22 and Feb. 18, May 6, and 10, 1909 (F. M. Jones).

Aedes sollicitans Walker, (*Culex sollicitans* Walk.). The salt marsh mosquito, July 6-12 (Kincaid); Walsingham, Feb. 16, April 5 (F. M. Jones).

Aedes taeniorhynchus Wiedemann. (*Culex taeniorhynchus* Wied.), July 7-23 (Kincaid).

Culex quinquefasciatus Say, (*C. fatigans* of Theobald not Wiedemann; *C. cubensis* Bigot). Record by Theobald from collections made by Dr. Eldon Harvey, July 1899.

MYCETOPHILIDAE.

Sciara sp. June 25 (Kincaid).

CECIDOMYIDAE.

Cecidomyia sp. June 25 (Kincaid).

Cecidomyia sp. June 25 (Kincaid).

BIBIONIDAE.

Dilophus breviceps Loew. Warwick Swamp, April 16, (c^g ♀). "In sweep net, in great numbers on one occasion only." (F. M. Jones).

Scatopse pygmaea Loew. June 28 and 30 (Kincaid).

Scatopse atrata Say. Recorded by Prof. Verrill.

STRATIOMYIDAE.

Hermetia illucens Linne. July 1 (Kincaid); May 13 (F. M. Jones).

Odontomyia bermudensis sp. nov.

Female: This species is closely related to *O. cincta* Oliv. and might be considered by some only a variety, but the apparent constancy of the seven specimens before me seems to warrant their separation. The two principal characters which readily distinguish this species are the conspicuous black stripes extending from the humeri to the base of the wings, dividing the green lateral stripes of the thorax from the green pleura, and the dark brown color of the larger vein, this color also extending over the costal and marginal cells and the base of the wing. Minor characters are the greater amount of black on the head, the black of the vertex being often connected with the large black orbital spots of the front, from which extend narrow curved lines to the frontal suture, and a narrow frontal stripe, which is also often present. The black markings of the abdomen are much larger, covering fully two thirds of the surface, while in *O. cincta* the black rarely exceeds one half. Six of the specimens have a dark yellow scutellum, but this may be a discoloration, as it occasionally appears in *O. cincta*. Length 10 to 12mm.

Six specimens, May 9 and 11 (Jones); one specimen, July 26 (Kincaid). "Not rare on the flowers of wild carrot, especially along the borders of the Warwick Marshes" (F. M. Jones).

TABANIDAE.

Tabanus atlanticus sp. nov.

Female: Face white with white hairs, above the base of the antennae slightly yellowish; front with grayish pollen and brown hairs, callosity large, shining black, with a short, slightly roughened line extending upwards; palpi light yellow with black hairs, proboscis brown; antennae yellow, with tufts of black hairs on the upper and of white hairs on the under sides of the first and second joints, third joint not angulate, annuli brown. Thorax gray with four obscure

brown stripes, hairs whitish; pleura mottled with bluish-black and covered with whitish pollen and hairs; scutellum grayish. Abdomen brown with a lighter posterior margin on each segment, the entire surface with a white pubescence. Legs yellow, under side of the posterior femora and tips of all the tibiae and tarsi brown, front coxae with long, white hairs; halteres light yellow. Wings hyaline, stigma and cross-veins clouded with brown. Length, 13mm.

The ♂ differs but little from the ♀, except that the facets on the upper two-thirds of the eye are double the size of those on the lower third. The stripes on the thorax are obsolete. Length 10mm.

Three specimens collected by Professor Kincaid, July 10 and 30.

Tabanus nigrovittatus Macquart.

In writing to Mr. Jones regarding a larger horse-fly than this species, he says: "This is undoubtedly the 'large horse-fly' you asked me to look out for; the carriage-drivers assured me that no larger species occurs here. It is said to be locally abundant in the summer time, but up to May 20 I saw only one living example; the other specimen I got from a local collector who confirmed the drivers' statement." It seems, therefore, probable that the reference to a larger species. (Psyche vol. XI, p. 77) applies also to this species.

SCENOPINIDAE.

Scenopinus nubilipes Say. One specimen, May 15 (F. M. Jones).

ASILIDAE.

Asilus? sp. Recorded by Professor Verrill.

DOLICHOPODIDAE.

Sciapus chrysoprasius Walker. Not rare, March 20, 30 and May 12 (F. M. Jones).

Sciapus pallens Wiedemann. Three specimens, April 17, May 18 and 19, resting on the white walls. (F. M. Jones).

Diaphorus configuus Aldrich. Seven specimens, June 30 to July 26 (Kincaid).

Chrysotus picticornis Loew. Three specimens July 15 (Kincaid). Common, Spanish Point, July 5 (Spaeth).

Chrysotus bermudensis sp. nov.

Front shining green, face with silvery white pollen; antennae black, small. Thorax and scutellum shining green, slightly covered with a yellowish pollen; pleura greenish black, with whitish pollen. Abdomen shining with a narrow bronze band at the base of each segment. Legs including the front coxae yellow, middle and posterior coxae black; a preapical band on the posterior femora, and the extreme tips of the tarsi dark brown. Halteres, tegulae and cilia light yellow, wings grayish hyaline. Length, 2mm.

Three females, June 20, July 26 (Kincaid). Holotype in the author's collection; one paratype in the Museum of Comparative Zoology. This species is closely related to *C. pallipes* Loew, but seen readily separated from that species by the dark preapical band on the posterior femora.

PIPUNCULIDAE.

- Pipunculus insularis** Cresson, (Trans. Amer. Ent. Soc., vol. 36, p. 317, 1911). Hamilton parish, May (S. Brown); July 29 (Kincaid); Agar's Island, June 18, and Spanish Point, July 5 (Spaeth).
- Pipunculus albiseta** Cresson, (Trans. Amer. Ent. Soc., vol. 36, p. 318, 1911). Hamilton Parish, May, (S. Brown); Jan. 27 (F. M. Jones).
- Allograpta obliqua** Say. "Abundant throughout the winter," Dec. 11 to Jan. 25 (F. M. Jones); Agar's Island, June 18 (Spaeth).
- Toxomerus marginatus** Say. (*Mesogramma marginatum* Say, of the previous list). "Very abundant and present throughout the winter and spring (Dec. 8 to May 3). A specimen was bred April 1, from a larva found in the flowers of the Bermuda blue-eyed grass." (F. M. Jones). On the road from Hamilton to Grasmere (Spaeth). The larvae are aphidiivorous.
- Eristalis tenax** Linne. "The first specimen was taken February 18; afterwards not rare on flowers, but never abundant." (F. M. Jones).
- Eristalis æneus** Scopoli. (*Lathyrophthalmus æneus* Scop.). "Most abundant on flowers along the cliffs of the south shore, where it was present throughout the winter" (F. M. Jones). Specimens bear the following dates: December 14, 21; January 19; February 6 and March 4.

SARCOPHAGIDAE.

- Sarcophaga georgina** Wiedemann? Both Professors Walker and Verrill referred the large flesh fly of the Island to *S. carnaria* Linne. Among the series collected by Messrs. Davis, Kincaid and Jones there is not a specimen referable to that species. They represent the large species with reddish genitalia which I have referred doubtfully to *S. georgina*.
- Sarcophaga assidua** Walker. Numerous specimens agree with the description of this species. Feb. 24, April 16 and May 5 (F. M. Jones); Spanish point, July 5 (Spaeth); July 6 (Kincaid).
- Sarcophaga** sp? Probably two closely related species. The present unsatisfactory condition of our Sarcophagidae precludes the possibility of accurately determining the species.
- Helicobia helcis** Townsend. Common, April 18 and 26 (F. M. Jones). Spanish Point, July 5 (Spaeth).
- Sarcophagula** sp. Recorded by Dr. Dahl. I was in hopes of finding the common *S. imbecilla* v. d. W. of the West Indies among the material studied.

MUSCIDAE.

- Musca domestica** Linne. The common house-fly is abundant throughout the year. June 20 (F. M. Jones); Agar's Island, June 18, and Spanish Point, July (Spaeth).
- Stomoxys calcitrans** Linne. The biting house fly or cattle fly. Abundant with the common house-fly, June 20 (F. M. Jones); Agar's Island, June 18 (Spaeth); July 11 (Kincaid).
- Synthesiomyia brasiliiana** B. & B. July 29 (Kincaid).
- Calliphora vomitoria** Linne. Recorded by Prof. Verrill.

Lucilia sericata Meigen. Abundant. Dec. 25 to May 12 (F. M. Jones); July 12-29 (Kincaid); Spanish Point, July 5 (Spaeth). *L. latifrons* Schiner is a synonym.

Lucilia caesar Linne. Recorded by Prof. Verrill.

Lucilia problematica sp. nov.

Male: Front linear as in *L. caesar*, black, orbits whitish pollinose; face black, whitish pollinose, the oral margins and antennae reddish brown, arista black. Thorax and abdomen bronze black shining, with a slight whitish pollen especially on the sides and on the pleura. Two post-acrosticals. Femora and tibiae brown and the tarsi blackish. Squamæ and halteres yellow, wings brownish hyaline. Length 7mm.

Female: Similar to the male, front, as in *L. caesar*, one-third the width of the head.

Holotype June 30 (Kincaid); allotype March 1899 (Montgomery), in the author's collection. This interesting species has been in my collection for some time awaiting more material. The first specimen (♀, antennæ wanting) was collected by Mr. Thomas L. Montgomery in March, 1897. A teneral specimen (♂) was taken by the late C. Abbott Davis, July 11, 1903. These were submitted to the late D. W. Coquillett at the time I was preparing my previous list, but he declined to name them without more material. The third specimen (♂) was taken by Prof. Kincaid, June 30, 1905, and a fourth specimen (♀ teneral) by Mr. Frank M. Jones, March 1, 1909. It is close to *L. caesar* in every respect but color; the entire absence of green or blue, however, seems to preclude placing it in that species. I had hoped that a larger series would show variations approaching that species, but while *L. caesar* was mentioned by Prof. A. E. Verrill, the large series of *Lucilia* brought from the Islands by Messrs. Montgomery, Davis, Kincaid and Spaeth, contained only *L. sericata*.

ANTHOMYIDÆ.

Ophyra aenescens Wiedemann. July 6 (Kincaid); December 26 (F. M. Jones).

Fannia pusio Wied. (*F. femorata* Loew) May 9 (F. M. Jones); July 6 (Kincaid).

Fannia polychæta Stein. This is based on *Anthomyia lepida* Meig., recorded by J. Matthew Jones in 1876. It is a doubtful species, referred with a question to this species.

Limnophora narona Walker. (*L. cyrtoneurina* Stein) collected by C. A. Davis, July 14.

Mydæa sp? One imperfect specimen, July 17 (Davis).

Phyllogaster cordyluroides Stein. June 30 and July 12 (Kincaid).

Phorbia fusciceps Zetterstedt. Common, December 26 (F. M. Jones); June 30 and July 29 (Kincaid); Agar's Island, June 18; on the road from Hamilton to Grasmere, June 26; Spanish Point, July 5 (Spaeth). This species infests onions and other vegetables, and is undoubtedly the fly referred to by Verrill as "*Anthomyia ceparum*," "onion fly."

Coenosia sp? July 6 (Kincaid).

- Lispa albitarsis** Stein? Spanish Point, July 5 (Spach). A female agrees with this species except that the palpi are blackish.
Fucillia marina Macquart (*F. fucorum* of authors, not Fallen). In great number on piles of sea-weed, March 6 (F. M. Jones).

SCATOPIAGIDÆ.

- Scatophaga** sp? Recorded.

BORBORIDÆ.

- Leptocera fontinalis** Fallen, (*Limosina fontinalis*). July 2 (Kincaid).
Leptocera venalicia Osten Sacken. May 3 (F. M. Jones). Supposed to have been introduced into Cuba by the slave trade.
Leptocera illota Williston. Spanish Point, July 5 (Spach).
Leptocera sp. Three specimens of a smaller species from a pile of sea-weed, February 4 and March 6 (F. M. Jones). The specimens are imperfect.

Borborus minutus sp. nov.

Male: Front covered with light brownish pollen, two dark brown stripes extending upward from the base of the antennae and over the vertex, the stripes bearing a narrow whitish line above the antennae, face brown, cheeks whitish pollinose, antennae black. Thorax light brownish pollinose with three dark brown stripes, the middle one double the width of the others, scutellum light brown, the disc and apex slightly darker, pleura brownish pollinose. Abdomen dull grayish black. Legs black, the posterior metatarsis about double the width of the following joint. Halteres yellow. Wings grayish hyaline, veins dark brown. Length 2mm.

Holotype, Spanish Point, July 5 (Spach), in the author's collection. Two paratypes, Horse Neck Beach, Mass., July 8, 1896, in the collection of the Boston Society of Natural History. The latter were collected by Dr. Garry de N. Hough, and were in my collection for a number of years. I have adopted a manuscript name proposed by Dr. Hough.

SCIOMYZIDÆ.

Tetanocera kincaidi sp. nov.

Male: Face and inferior orbits white, with a brown stripe on the cheek extending from the eye to the oral margin; front yellow, the frontal vitta and a transverse stripe extending from the base of the antennae to the orbits brown, frontal orbits narrow, white; antennae yellow, the bristles and hairs on the second joint and the arista black. Thorax yellow, with two narrow dorsal lines and broad lateral stripes of brown; pleura light yellow with a broad brown stripe; scutellum yellow with four black marginal bristles. Abdomen brown, lateral margins and the genitalia yellow. Halteres light yellow. Legs yellow, a spot on the under side of the middle and posterior femora somewhat beyond the middle, tips of the tibiae and the tarsi blackish, due in part to the blackish hairs, middle coxæ with a tuft of black bristles below, front of the anterior coxæ bearing three bristles. Wings similar to *T. spinicornis* Loew, but proportionately broader and the reticulations less profuse, with five unequally arranged square hyaline spots in the marginal cell beyond the end of the first vein. Length, 5mm.

Female: Similar to the male, but with an obsolete dorsal line on the abdomen. Length 6mm.

Ten Specimens. Holotype, July 29, allotype June 26, 1905 (Kincaid) and three paratypes, May 30 (Mowbray); January 12 and February 5 (F. M. Jones) in the author's collection. Paratypes also in the Museum of Comparative Zoology, and in the Collections American Entomological Society.

With only two poor specimens before me this was referred to *T. spinicornis* in my previous list. It closely resembles that species but can be readily separated by the wings as described above, the single, not double spots on the under side of the posterior femora and the larger and less acute third joint of the antennæ. It is also slightly larger.

The species also resembles *T. setosa* Coq. but the spots on the under side of the posterior femora and the five unequally arranged hyaline spots in the marginal cell beyond the end of the first longitudinal vein distinguish it from that species.

Tetanocera (Dictya) umbrarum Linné (*T. pictipes* Loew, Monog. N. Amer. Diptera, I, 111, 1862). Two specimens, March 20 (F. M. Jones); July 15 (Kincaid).

SAPROMYZIDÆ.

Sapromyza saroria Williston. July 6 and 11 (Kincaid); Jan 6, April 10 and May 4 "On the under side of palmetto leaves in a swamp" (F. M. Jones).

ORTALIDÆ.

Euxesta abdominalis Loew. June 30 (Kincaid). Sweep net, Warwick Marshes, December 11, also March 5 (F. M. Jones).

Euxesta annonae Fabricius. June 26 (Kincaid).

Euxesta pusio Loew. June 26 (Kincaid).

Chaetopsis fulvifrons Macquart (*Urophora fulvifrons* Macq. Dipt. Exot. Suppl. V, 125, pl. VII, fig. 8, 1855). July 29 and 30 (Kincaid); March 20 (F. M. Jones). This is probably the same as the *C. aenea* of my previous list, as recorded by J. Matthew Jones in 1876. It differs from the true *C. aenea* in lacking the frontal cross-bristles and in having only three or four frontal orbital bristles.

Chaetopsis debilis Loew. Spanish Point, July 5 (Spaeth). This may prove to be only a variety of *C. fulvifrons* Macq. as the color of the basal segments of the abdomen and the bands on the wings, are both apparently variable characters.

Ceratitis capitata Wied. "Fruit fly."

This fly which was introduced sometime prior to 1870 is still on the Islands but in very limited numbers owing to the vigorous campaign that has been waged against it. The authorities deserved great credit for their perseverance in endeavoring to exterminate this insect and we hope that in the near future they may again be able to resume the raising of the various fruits affected. There is little doubt that this vigorous action has for many years checked the western movement of this great fruit pest.

Having written to Mr. F. M. Jones in May, 1909, to ascertain if the fruit fly was still on the Islands, he replied: "In regard to the fruit fly (*Ceratitis*); several years ago a regular crusade against this insect was undertaken and is being continued. All of the Surinam cherry trees were cut down, also most of the sweet orange trees and peach trees. Inspectors were appointed in each parish and authorized to visit every tree and strip off the unripe fruit,—oranges, lemons, sapodilla, loquats, sugar-apples, etc.; pawpaws were ordered to be gathered before turning yellow, under the penalty of having the trees chopped down. All this was in an effort to entirely exterminate the insect, it has undoubtedly greatly reduced its numbers for I failed to find a specimen, though I searched all kind of fruits where I could find any which had escaped inspectors. I heard of the fly as still present this spring. The crusade has not the support of the people and trees are concealed from the inspectors when possible, so that probably when the vigilance is relaxed the insect will appear again. There are several wild fruits which should be examined as possible breeding places. Sorry I could not get you some specimens."

Expressing to my friend Dr. R. A. Spaeth a desire to obtain some specimens of the "fruit fly" he spoke to Col. W. R. Winter who bred some specimens which I received through the kindness of Professor E. L. Mark. The letter accompanying the specimens contains so much of interest pertaining to the habits of the fly that I have taken the liberty of publishing it in part.

"With reference to the experiments, several punctured peaches placed in isolation cages, developed flies in from seven to ten days from the time in which the larvæ entered the soil, as I had not the actual date of the depositing of the eggs, I did not trouble to keep an exact record beyond noting the dates of the larvæ leaving the fruit and the appearance of the fly."

"Two peaches in perfect condition were left on an exposed branch of the tree and watched, but owing to the scarcity of flies it was not until 4 P. M. on the 13th of July that a fly appeared and punctured one of them; after ten minutes I killed the fly. The peach was carefully examined and one puncture only was found. On the 17th the fruit was found to be soft around the puncture and was gathered. It was placed in a gauze covered glass jar on two and a half inches of clear, dry sand. On the 24th at 10 A. M. the maggots were observed going into the sand, many of them being visible through the sides of the glass, they having gone down between the sand and the glass. On the 27th the peach was removed and examined. Two dead maggots were found in it. The pupæ were carefully separated from the sand and twelve more were found, these were placed in dry soil in an isolation cage made especially for this experiment. The flies appeared as follows: two on the 1st of August at 7 and 10 A. M. Three on the 2nd, before 4 P. M. Two on the 3rd, before 7 P. M., and on the 4th, before 9 A. M. Carried no further as all flies fed on arsenate of lead which was placed in the cage and were found dead on the 5th at 7 A. M. Weather very hot and dry, no rain, temperature averaging 82°.

Aciura insecta Loew. June 26 (Kincaid); Spanish Point, July 5th (Spaeth).

Ensina picciola Bigot, (*Trypeta humilis* Loew). ~ Abundant in sweep-net, December 8 and 29 and May 17 (F. M. Jones). Road from Hamilton to Grasmere June 26 and Spanish Point July 5 (Spaeth).

SEPSIDÆ.

Sepsis violacea Meigen. ~ Common January 21 and April 29 (F. M. Jones); June 30 and July 29 (Kincaid); Spanish Point, July 5 (Spaeth).

Piophilæ casei Linné. The cheese fly. Recorded by Prof. Verrill.

EPHYDRIDÆ.

Mosillus nana Walker? (*Ephydra nana* Walker, Trans. Ent. Soc., London, N. Ser. IV, 234, 1857). July 30 (Kincaid); Spanish Point, July 5 (Spaeth).

Ephydra austrina Coquillett. One specimen collected by C. A. Davis.

OSCINIDÆ.

Hippelates plebeius Loew. June 28 and 30 (Kincaid); Agar's Island, June 18 (Spaeth).

Hippelates pusio Loew. July 12 (Kincaid).

Oscinis coxendix Fitch. Common. June 30 and July 12-18 (Kincaid); February 4 (F. M. Jones); near Hamilton, June 26 and Spanish Point, July 5 (Spaeth).

Oscinis trigramma Loew. July 11, 15 and 26 (Kincaid).

Oscinis umbrosa Loew. Common, June 25 to July 29 (Kincaid).

DROSOPHILIDÆ.

Drosophila adusta Loew. July 25, 29 (Kincaid); February 4 (F. M. Jones).

Drosophila ampelophila Loew. January 7 (F. M. Jones).

Drosophila repleta Wollaston, (*D. punctulata* Loew, Berl. Ent. Zeits., VI, 232, 1862; *D. adspersa* Mik, Wien. Ent. Zeitg., V, 328, 1886) January 1 and May 6 (F. M. Jones).

Paratissa pollinosa Williston, July 10 (Kincaid); December 24 and March 6, on sea-weed (F. M. Jones).

AGROMYZIDÆ.

Phytomyza sp. January 27, February 24 (F. M. Jones).

Agromyza æneiventris Fallen. July 1 (Kincaid).

Agromyza pusilla Meigen. July 5 (Kincaid).

Agromyza maculosa Malloch. May 17 (F. M. Jones).

Desmometopa m-nigrum Zetterstedt, May 9 (F. M. Jones).

Milichiella lacteipennis Loew. (*Ophthalmomyia lacteipennis*). July 9, 12 and 28 (Kincaid); Spanish Point, July 5 (Spaeth).

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**THE TAXONOMIC VALUE OF THE CHARACTERS OF THE MALE
GENITAL ARMATURE IN THE GENUS
TETRANYCHUS DUFOUR.**

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INTRODUCTION.

The red spiders of the genus *Tetranychus* Dufour have always offered a knotty problem for systematists working in the order Acarina. When these mites were first noticed they were found on such a multitude of host plants, and showed such a great variation in color that the early workers considered the genus as being made up of a great many species or varieties. Later it was found that certain well known forms could have a great variety of hosts, also that there was a considerable variation in size and color among individuals on a single host plant. Then there was a tendency to lump the forms together into a very few species, although confusion as to synonymy still remained. In 1877 Professor A. T. Tozzetti called attention to the systematic value of the characters of the mouth-parts and of the tarsal appendages. Later Professor A. Berlese made use of some very important characters, the variations of the specialized setae on the palpal thumb. In 1900 Mr. N. Banks in his, "Red spiders of the United States," showed that the characters used by both of these authors were of special value in helping to separate our American forms. It is to Mr. Banks that we should give the credit for first straightening out many of the synonymous and wrongly determined species found in our country. But as yet, both in this country and in Europe, there is much confusion in regard to the identity and synonymy of some of our best known and most injurious species.

After examining hundreds of specimens from many parts of the United States, with magnifications up to 2000 diameters, and using an oil emersion lens, the present writer has found that the genital armature of the male is excellently adapted for systematic purposes.

The genital armature of the male may be considered as being composed of the penis, its attachments, and the slit-like opening through which it is protruded. For our purposes the penis alone

will be considered, as it is well chitinized, quite visible, and offers great variations among different species, while only a few exist among individuals of a single species taken from the same host plant.

GENERAL STRUCTURE OF THE PENIS AND EXPLANATION OF TERMS USED IN REFERENCE TO ITS PARTS. (See Figure.)

Inner lobe—The imbedded or attached part of the penis. It is much less chitinized than the penis proper.

Shaft—The free part of the penis. It is much more strongly chitinized than the inner lobe.

Basilar lobe—The enlarged proximal part of the shaft. It is not always present.

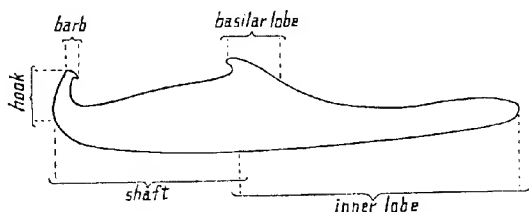


FIG. 1. Penis of male of *Tetranychus telarius* Linn., as seen from the right side, X 1800; showing the various parts delineated and labeled.

Hook—The dorsally curved distal part of the penis. It is frequently absent.

Barb—The flattened or knobbed or bent tip of the penis.

KEY TO THE MALES THUS FAR EXAMINED.

- I. 1. Penis long, tapering, without hook.
 - II. 1. Penis without basilar lobe; long, seta or spine-like.
 - III. 1. Shaft less than 0.04 mm. in length, frequently doubly curved. *T. weldoni* n. sp.
 - III. 2. Shaft over 0.06 mm. in length, with but a single curve. *T. longipes* Banks.
 - II. 2. Penis with swollen part at the base of the shaft (basilar lobe).
 - III. 1. Shaft strongly curved; without barb. *T. flavus* n. sp.
 - III. 2. Shaft less curved; with flattened barb. *T. borealis* n. sp.
- I. 2. Penis short, stouter, with hook.
 - II. 1. Hook without barb.
 - III. 1. Hook bent at an angle of from 30° to 50° to the axis of shaft. *T. mytilaspidis* Riley.
 - III. 2. Hook bent at an angle equal to at least 90° to axis of shaft. *T. pratensis* Banks.
 - II. 2. Hook with prominent, flattened, recurved barb. *T. telarius* Linn.

NOTES ON OLD SPECIES AND DESCRIPTIONS OF NEW ONES.

In these notes three new species are for the first time here delineated. Before long the writer hopes to publish complete descriptions of these together with illustrations of those structures having special systematic importance.

***Tetranychus telarius* Linn.**

Acarus telarius Linn.—Fn. Suec., 181, No. 1974 (1761).

This species appears to have the following American synonyms:

Tetranychus sexmaculatus Riley (?)—Insect Life, Vol. II., p. 225. (1890).

Tetranychus 2-maculatus Harvey—Ann. Rep't. Maine Agric. Exp. Sta., part IV., p. 133, Pl. III. (1892).

Tetranychus gloveri Banks—The Red Spider of the United States, Tech. Ser. No. 8, Div. Entom., U. S. Dep't. Agri., p. 76. (1900).

This is our most common and most widely distributed species of red spider. It is also the most common species found in Europe. I give the following description of the penis of the male:

Penis short, stout. Inner lobe long, rod-like; longer than the shaft, and somewhat bent. Shaft thick, stout, short, much stouter at its base than at its distal end where it bears the prominent hook. Basilar lobe present, on the upper side of the shaft; it is small, protrudes slightly, and is hook-like in shape. Hook short, stout, extending dorsally; three or four times as broad at its base as it is at its apex; it forms an angle of over 90° with the apex of the shaft. Barb present at the end of the hook, flattened and recurved.

That our well known *T. 2-maculatus* Harvey is synonymous with *T. telarius* Linn. there can be but little doubt. I have sent specimens to Professor A. Berlese, of Italy, and after comparing them with the European species, he writes that they are the same. I have sent specimens to Dr. A. C. Oudemans, of Netherlands, and he states that they equal *T. telarius* L. I have received named female specimens of European individuals of *T. telarius* Linn. from Dr. Oudemans, which were collected from English elm (*Ulmus campestris* L.) at Amsterdam, October 1910. I have compared these females with the females of our *T. bimaculatus* Linn. I find in these specimens the presence of the same six bristles near the base of the tarsal pedicel of leg I. The four tenent hairs are similarly arranged and shaped in every respect as they are in our species. The tarsal pedicel is similar to our species. The tarsal claw is six cleft, and exactly like those I have examined in America.

In the case of the palpal characters I find the same claw, thumb, finger, and sense hair; and each with the same form, relative size, and position as in our species. The thumb also bears the same three bristles; and one of the terminal spines is present. I find difficulty in getting a specimen in the right attitude to show both of the terminal spines properly.

The females show the structures of the genital and anal areas to be the same as in our species. The plate in front of the vulva is the same, and has the common two bristles. The anal papilla is the same as in our species, and is flanked on each side by two bristles as in our species. These bristles are of the same size, and are situated as in our species.

In this country Mr. Banks and others have recognized a form which has passed under the name of *T. telarius* Linn. I have compared our American forms of *T. telarius* Linn. with our *T. bimaculatus* Harvey, and I will state that after examining hundreds of specimens of both supposedly distinct species from many States (East, West and Middle) in this country, I can find no structural difference between the two. Mr. Banks, in his "Red Spiders of the United States," represents the thumb of the palpus of *T. bimaculatus* Harvey as bearing but one distal digit, a long seta, and a basilar spine; the thumb of *T. telarius* Linn. as bearing three distal digits, two small setae, and no basilar spine. By means of treatment with chloral hydrate solution or other clearing agencies, and by use of magnifications of over 2000 diameters, I find that there are more appendages to the thumb in both cases than Banks has represented. I find in both cases that the palpal thumb bears a large stout digit at its tip, above this two small, diverging spines or digits. Near the base in both cases is the spine which Banks has figured for *T. bimaculatus* Harvey. Toward the tip of the thumb and below the big finger is a large, curved seta also shown in Banks' figure of *T. bimaculatus* Harvey. Behind the basilar spine I find in all instances two more prominent bristles not figured in either Bank's drawing of *T. bimaculatus* Harvey or his drawing of *T. telarius* Linn.! Also I find that the tarsal claw in both cases is six-cleft instead of being four cleft as stated in Bank's paper!

There are some other points which I should like to mention in regard to the synonymy of these two species, but for the present I shall stop with these.

Tetranychus sexmaculatus Riley may be the same as *T. telarius* Linn. I have received many specimens of this species, sent by Professor H. J. Quayle, from Southern California. I find that the females agree with the females of *T. telarius* Linn. in every minute detail of structure. I have transferred live individuals to the common host plants of *T. telarius* Linn. Here they have not thrived successfully. In most cases they would not establish themselves. Unfortunately I have never examined a male of *T. sexmaculatus* Riley, and since so much depends upon the characters of the male genital armature we cannot be sure of the synonymy of the two species until a male specimen is examined.

Tetranychus gloveri Banks appears to be the same as *T. telarius* Linn. I have received scores of individuals of *T. gloveri* Banks, on cotton, from Georgia, sent by E. L. Worsham. These agree in all respects with my specimens of *T. telarius* Linn. collected from many places in the United States, and with the specimens of *T. telarius* Linn. received from Europe. Professor A. Berlese has examined specimens of *T. gloveri* Banks from cotton, and has considered it as being the same as *T. telarius* Linn.

***Tetranychus weldoni* n. sp.**

I have received many specimens of red spiders from G. P. Weldon labeled *T. bimaculatus* Harvey. For a long time I have considered that they were this species, which is, as I have shown, a synonym of *T. telarius* Linn. Recently I have found that the male is different from the male of the *T. telarius* Linn.

Female: Similar in all respects to the female of *T. telarius* Linn.

Male: Different from male of *T. telarius* L. in character of penis and spur on palpus. Spur on palpus not so pointed as in *T. telarius* Linn. Penis very long, rod-like; equal to a third the length of the body. Inner lobe short, rod-like, slightly swollen at its anterior end. Shaft, rod-like, not setiform; gradually tapering to you part backward; posterior one half turned upward; tip narrowly rounded, not pointed. Basilar lobe absent. Hook absent. Barb absent.

From Grand Junction, Colorado; on apple, prune, and cotton wood; by G. P. Weldon.

***Tetranychus borealis* n. sp.**

Female: Similar to the female of *T. telarius* Linn. but smaller, and never orange or red. The inner prongs of the tarsal claw are stouter than the inner prongs of the tarsal claw of *T. telarius* Linn.

Male: Similar to the male of *T. telarius* Linn., except for the penis. Penis long, straight. Inner lobe about equal to basilar lobe in length. Shaft shaped like a slender rod. Basilar lobe very pronounced, cone-shaped, equal to about one fourth the length of the shaft. Hook absent. Barb knob-like.

From Coast Range Mountains, Benton Co., Oregon; on *Spiraea* sp.; by the writer.

This form is very closely related to another species, the description of which follows.

***Tetranychus flavus* n. sp.**

For over a year I have been studying a form of red spider which is a serious orchard pest in Oregon. It especially is injurious to apples when they are growing above an elevation of 1000 feet above sea level. In Hood River Valley I have found this form so serious as to discolor the leaves of whole orchards of apples, and in some instances as to cause defoliation late in the summer. When fall comes and the trees drop their leaves, these mites all become a pale yellow in color and collect in masses about the trunks of trees and the cracks of the ground for a region of several feet from the tree bases. Here they pass the winter, and become active again in the spring when the trees put out their foliage. At first I considered this species as but a form of our common *T. telarius* L. After studying these two forms for two seasons in the laboratory, I find that they must be considered as distinct species. This species is even more closely related to the one just described, *T. borealis* n. sp. It may be described as follows:

General appearance similar to *T. borealis* n. sp.; also similar to *T. telarius* Linn., but the individuals are smaller. Color of immature forms green or yellow; of adults green or yellow, with black markings not pronounced. Adults are never orange or red. In the winter when deprived of food supply all instars yellow. General structures similar to those of *T. telarius* Linn., but the tarsal claw in most instances is only five-cleft, the two inner prongs being united. In *T. telarius* Linn., the tarsal claw is, I find, six-cleft; however, it has been represented by others as being four-cleft. In the case of the female of *T. flavus* the anal spines are situated farther forward than in *T. telarius* Linn., and also nearer the margins of the genital slit or opening. This species differs from *T. borealis* n. sp. in the tarsal characters which are nearer those of *T. telarius* Linn., and in having no barb to the penis.

The penis of this species is entirely different from the penis of *T. telarius* Linn. It is long and spine-like. In length it is equal to a third or fourth of the entire length of the body. Inner lobe of penis not prom-

inent, slightly swollen at its anterior end; in size, smaller than the basilar lobe of shaft. Shaft long, curved, and resembling the sting of a wasp; varying greatly in curvature, generally bending downward, then upward, or it may have but a single curve, or it might be straight. Basilar lobe, large, subcylindrical, equal to over one fourth of the total length of the entire shaft. Hook and barb absent.

Generally distributed over Hood River Valley, Oregon; on apple trees especially; observed and reported by many people. Found in some places in the Willamette Valley, Oregon; on apples; by the writer. Probably present throughout the Pacific Northwest above altitudes of 1000 feet.

***Tetranychus pratensis* Banks.**

Tetranychus pratensis Banks—Proc. Entom. Soc. Wash., Vol. XIV, p. 97. (1912).

I have examined specimens of this species, and find that the tarsal appendages are very peculiar. I find that there are two claws as stated by Banks, but only one, the outer, is simple. The inner claw is bent downward very near its base, and beyond this bend it is three cleft. On each side of the tarsal claws is a short projection from which extends a pair of tenent hairs. The penis of the male may be described as follows:

Inner lobe slightly over one half as long as the shaft of the penis. Shaft stout, somewhat similar to the shaft in *T. telarius* Linn.; enlarged slightly at its base so as to form the basilar lobe. Hook pronounced; bent at an angle of about 90° to the axis of the shaft. Barb absent.

From Pullman, Washington; on timothy; by G. R. Hyslop.

***Tetranychus mytilaspidis* Riley.**

Penthalodes mytilaspidis Riley—Hubbard, *Orange Insects*, p. 216. (1885).

This very characteristic red spider differs from most of our species in having the bristles of the body arising from prominent tubercles. In many respects it is about as far removed from *T. telarius* Linn. as any of the species of the genus. In the characteristics of the male genital armature it appears to be rather closely related to *T. telarius* Linn. The penis may be described as follows:

Inner lobe about one and a half times as long as the penis proper; not swollen at its anterior end. Shaft very short, and stout. A basilar lobe present in the form of a stout, more or less hook-like, protuberance on the dorsal side of the shaft. In this respect the penis is like that of *T. telarius* Linn. Hook very large, stout; bent at an angle of from 30° to 50° degrees to the axis of the shaft. Barb absent, but the distal part of the hook is bent out considerably.

Generally distributed in Southern California on citrus trees, also found on deciduous trees. A serious pest of stone and pomaceous fruit trees in certain parts of Oregon.

***Tetranychus longipes* Banks.**

***Tetranychus longipes* Banks**—Proc. Entom. Soc. Wash., Vol. XIV., p. 27. (1912).

This species is so different from most of the other species in the genus, that it might well be made the type of a new genus. It has strong affinities with the genus *Bryobia*; in the general shape of the body, in the length of the anterior pair of legs, in the possession of the horn-like setae at the anterior end of the cephalothorax. I have examined the tarsal appendages of leg I, and find that with 2000 diameters magnification they are very complicated, and do not consist of two simple claws as Banks states. There is one large simple claw to the tarsus. Above this and apparently fused with it is a chitinous projection with many parallel hairs forming a comb. On either side of the tarsal claw is a pulvillus-like structure, each of which has several projecting tenent or other hairs.

I have observed but one male specimen of this species, and this specimen was very much dilapidated. What I have taken to be the penis may be described as follows:

Penis very large and long; much longer than the penis of any other species examined. Inner lobe about one third as long as the shaft, broadest at its base. Shaft long, curved, seta-like. Basilar lobe, hook, and barb absent.

From Springer, New Mexico; on grass (*Agropyron*); by C. N. Ainslie. From Holtville, California; by Wildermuth.

A SYNOPSIS OF THE DESCRIBED NORTH AMERICAN SPECIES OF THE DIPTEROUS GENUS TIPULA L.

By W. G. DIEHL, M. D.

The following synopsis is not offered to fill the proverbial long felt want, but rather that it may facilitate and lessen the labor of the student who undertakes the study of the above mentioned genus. It is based almost entirely on the original descriptions with the exception of those of Fabricius, and for these I have had to depend upon those of Wiedemann.*

Many of these fall short of completeness. Some, like those of Walker's, as was his custom elsewhere, are woefully defective. Fortunately not a few of these have been authentically recognized and wherever such was the case and representative material was at hand, I have drawn upon this source of information. It will readily be seen that this synopsis is not merely a synoptical table in the usual sense and hence, some explanatory remarks are deemed necessary. To give more certitude to the identification of a given species, the usual differential diagnosis is followed by a short detail description. In the latter, especial stress has been laid upon the structure and formation of the hypopygium—ninth segment—and the eighth abdominal segment of the male, though in many instances no information on these points was available. All references to the apical appendages of the male hypopygium have been omitted, important and almost absolute their consideration becomes in the separation of otherwise very closely allied or similar forms, as this would have led far beyond the scope of this paper. It must be remembered that all references to the eighth and ninth—hypopygium—abdominal segments refer to the male, unless otherwise stated.†

In the use of the synopsis, a certain margin must be allowed for the interpretation of terms used. I have, as nearly as possible made use of the identical language of the authors in their descriptions and in the translations from the Latin have kept close to the sense of the writer. What to one observer might

* *Aussereuropäische zwei flügelige Insecten.* Vol. I.

† The term "ninth tergite" and "ninth sternite" in the text are the equivalents of "upper and lower lamella," respectively, used by writers.

appear as a fascia, might merely be looked upon as a spot by another and vice versa. Under the heading, "Wings Spotted," species may have been included which might with equal propriety have been placed under "wings unicolorous" and the reverse. Whenever I have been conscious of such being the case, I have endeavored to remedy the difficulty by cross-references. To those who expect this synopsis to be an easy road to the goal, disappointment will come. To determine the relative position of a given form and then by close study of the original description and whenever possible, of the type, the student should be enabled with certain limitations, to determine whether a given form is described or not. To the critic this paper will furnish a rich field, more so perhaps, than the time and labor bestowed upon it should warrant.

Following the synopsis, I have added a list with habitat and bibliography of these species not contained in Prof. Aldrich's catalogue.

1. Wings normal in size in both sexes. 2
- Wings reduced in size, or vestigial, at least in the female. 165
2. Wings spotted or striped. 3
- Wings unicolorous; at most, costal margin and stigma fuscous, or a white, hyaline spot before the stigma, more rarely another behind it; veins may be margined with fuscous. 87*
3. Wings spotted, marbled or clouded. 4
- Not as above, but the costal margin, fifth longitudinal vein and posterior cross-vein more or less broadly margined with fuscous, apex of wing frequently infuscate; generally a pale hyaline vitta in the second basal cell. 73
4. With pale transverse fascia. 5
- Without such a fascia. 21
5. Wings conspicuously variegated with dark fuscous. 6
- Wings not, or inconspicuously variegated with fuscous. 15
6. Fascia behind the stigma. 7
- Fascia before the stigma. 10
7. Fascia angulate. 8
- Fascia not angulate. 9
8. Joints of flagellum bicolorous. Yellow, thoracic vittae gray; abdomen with dorsal stripe, ninth tergite narrowly emarginate in the middle; with two, rather sharp teeth from the middle of the posterior margin, lateral angles produced; ninth sternite very deeply and broadly divided; pleural plates distinct. Length 12-13mm. Eight sternite entire. *angulata* Loew
- Joints of flagellum unicolorous. Mesonotum with about six fuscous, somewhat irregular lines, the middle pair more widely separated anteriorly; abdomen trivittate; eight sternite entire; hypopygium medium-sized, ninth tergite with rather broad V-shaped emargination, its margin with several teeth; ninth sternite with V-shaped emargination; pleural plates distinct. Length 14-23 mm. *trivittata* Say

*There may be an indistinct fuscous spot over the origin of the praefurca. The whitish spot before the stigma is called ante-stigmal spot, in the text.

9. Fascia does not extend beyond the fourth posterior cell; joints of flagellum bicolorous. Brown; three mesonotal stripes, margined with darker brown; abdomen trivittate; posterior margin of ninth tergite with two triangular projections, between which is a deep, narrow U-shaped incision; ninth sternite with deep V-shaped incision; pleural suture distinct. Length 14-19 mm. *asteria* Doane
- Fascia reaches the posterior wing margin; joints of flagellum tricolorous. Brown; antennae long; mesonotal vitta very broad; abdomen trivittate; posterior margin of segments yellowish; hypopygium small; ninth tergite with a small, ninth sternite with deep and rather broad incision. Length 12 mm. (♂) *lucida* Doane
10. Fascia V-shaped, broken; joints of flagellum not bicolorous. Brown; yellow, mesonotal vitta broad. Abdomen spotted, trivittate; ninth tergite tumid, posterior margin with broad crescent-shaped incision, in the middle of which is a small semi-circular incision; posterior margin of ninth sternite bearing a pair of leaf-like appendages. Length 20 mm. (♂) *albimaculata* Doane
- Fascia not distinctly angulate 11
11. Joints of flagellum unicolorous; thoracic vitta not margined 12
- Joints of flagellum bicolorous; thoracic vitta margined; posterior cell 1-3 infusate. Dark-yellowish; mesonotal vitta broad; abdomen conspicuously trivittate. Length 14 mm. (♂) *fuliginosa* Say
12. Posterior cells 1-3 more or less white. Gray; mesonotal vitta broad; abdomen with three stripes; ninth tergite with median impression and slight incision; posterior margin of ninth sternite with a broad, blunt triangular process; pleural suture present. Length 17 mm. *attatipennis* Doane
- *albivittata* Doane sgn. 13
13. Posterior cells 1-3 not white 14
- Posterior margin of abdominal segments not paler. Brown; metanotum with three gray lines, margined with fuscous. Abdomen with dorsal stripe; ninth tergite with deep, broad V-shaped incision; ninth sternite with deep, very narrow incision. No pleural suture. Length 11 mm. (♂) *cylindrala* Doane
- Posterior margin of abdominal segments paler 14
14. A white spot in middle of first basal cell. Yellowish; mesonotum with four brown stripes. Abdomen trivittate; eighth sternite produced and narrowed behind, with shallow, rounded incision; hypopygium large; ninth tergite with a slight depression and two very small points; ninth sternite with shallow, rounded incision containing a pair of processes; nearly all the veins bordered with whitish. Length 17 mm. *spectabilis* Doane
- First basal cell without a white spot. Brown; mesonotum gray with five brown stripes; abdomen trivittate; ninth tergite with deep median furrow, posterior margin with small V-shaped incision; ninth sternite with broad deep incision containing two tumid processes. Length 18-25 mm. *mayae* Doane
15. Apex of wings blackish; a broad whitish, subapical fascia. Yellow, thorax trivittate; abdomen with dorsal line and indistinct lateral lines. Length 15 mm. (♀) *capitata* Loew
- Apex of wings not blackish 16
16. Joints of flagellum bicolorous. Median vitta of thorax obsolete, lateral vitta very distinct, fuscous; abdomen pale, last two segments and posterior margin of the remaining ones, dark fuscous; hypopygium large, ninth tergite prolonged posteriorly into a median, laterally compressed, blade-like process; ninth sternite with broad V-shaped incision, prolonged anteriorly into a narrow slit, from the base of which project two long setae. Length 9-12 mm. *fricata* Loew
- Joints of flagellum unicolorous 17
17. Antennae wholly fuscous 18
- Antennae not wholly fuscous 19

18. Origin of praefurca fuscous; mesonotum with six brown stripes, median pair broad, conspicuous. Brown; lateral and posterior margin of abdominal segments paler; eight sternite with median, short, two lobed appendage; hypopygium small, elongate, ninth tergite with deep V-shaped incision; ninth sternite narrowly divided in almost its entire length. Length 11 mm. (σ^7).....*tristis* Doane
- Origin of praefurca not fuscous; mesonotum with three dark stripes, each of which is divided by a light brown line. Brown; lateral margin of abdominal segments broadly, posterior narrowly paler; ninth tergite with deep, narrow V-shaped incision; no pleural suture. Length 13 mm. (σ^7).....*marina* Doane
19. A fuscous spot at beginning of praefurca..... 20
Without such a spot..... 22
20. Wings brownish, darker towards the apex, a faint spot in first basal cell, a whitish spot in posterior margin of axillary cell. Yellow; mesonotum with four stripes; abdomen trivittate, lateral stripes faint; eight sternite produced and narrowed posteriorly; hypopygium large, ninth tergite produced into two long, somewhat flattened triangular processes; ninth sternite with lateral appendages and posterior margin with two small median ones. Length 17 mm. (σ^7).....*armata* Doane
- Wings not so marked..... 21
21. Yellow, a whitish spot beyond the stigma. Mesonotal vittae more or less distinct; eight sternite semicircularly incised; ninth tergite divided by a median suture into two subrectangular processes; ninth sternite large, with downward projecting spatulate processes. Length 13 mm. (σ^7). 12 mm. (σ^7).....*derbyi* Doane
- Brownish yellow, no white spot beyond the stigma. Thorax with three brown stripes; abdomen with three distinct brown stripes, posterior margin of segments whitish; eight sternite with rounded incision of the posterior margin, lateral angles with triangular, hooked appendages; ninth tergite with broad, deep V-shaped incision; posterior margin of ninth sternite with broad U-shaped incision, containing a pair of tumid appendages. Length 15 mm. (σ^7).....*occidentalis* Doane
22. All posterior cells more or less white. Light brown; mesonotum with four rather broad vittae; abdomen with broad dorsal vitta; eight sternite narrowed posteriorly, emarginate at apex; ninth tergite small with deep V-shaped incision and narrow median depression; ninth sternite almost divided by a deep, U-shaped incision, containing a pair of tumid appendages. Length 11 mm. (σ^7).....*acutipleura* Doane
- Some or all posterior cells not tinged with white..... 23
23. Gray, fourth posterior cell except its apex, occupied by a fascia-like spot,† first posterior cell with a spot in the middle and extreme apex white. Thorax whitish, vittae slightly darker, not margined; abdomen trivittate. Length 14 mm.....*subfasciata* Loew
- Brown, posterior cells not white; the white fascia extends from before the stigma through outer parts of basal cells to the posterior margin. Mesonotum quadrivittate; anterior margin of abdominal segments darker brown; ninth tergite short, broad, with inconspicuous median ridge, posterior margin slightly emarginate, lateral angles ending in short, downward projecting processes; ninth sternite with broad, rounded incision, lateral angles with two lobed appendages. Length 10 mm. (σ^7).....*incurva* Doane

*see also 60.

†Would perhaps more properly be placed under species: "wings unicolorous, a large white spot before the stigma."

‡This spot can hardly be called a fascia.

24. Wings marked with pale and fuscous spots, or the latter only. 25*
 Wings marked with pale spots only. 26
25. A spot at base of basal cells. 26
 Without such a spot. 34
26. Thoracic vittæ margined with fuscous. 27
 Thoracic vittæ not margined. 33
27. Joints of flagellum bicolorous; abdomen of female very much elongated.
 Abdomen with lateral stripes; hypopygium small, ninth tergite short,
 rather broadly emarginate, ninth sternite more narrowly emarginate.
 Length $15\frac{1}{2}$ mm. (σ^7). 19-20 mm. (γ) *longicinctis* Loew
 Joints of flagellum unicolorous. 28
28. Color cinereous. 29
 Color brown. 32
29. Entire wing with dark fuscous and white spots. 30
 Not so marked. 31
30. Fourth posterior cell almost entirely white; ovipositor serrulate beneath;
 abdominal stripes indistinct. Length 23-24 mm. *tesellata* Loew
 First and fourth posterior cells white at base only. Abdomen with
 fuscous dorsal vitta and lateral lines; hypopygium small; ninth tergite
 small. Length 17 mm. *septentrionalis* Loew
31. Basal joints of antennæ yellowish-brown; abdomen yellowish with three
 brown stripes; wing veins, except in basal portion margined with
 fuscous. Length 30 mm. (γ) *lenophæa* Doane
 Basal joints of antennæ grayish-fuscous; abdomen yellowish-brown,
 stripes indistinct; hypopygium rather large, ninth tergite rather
 broadly emarginate posteriorly, the emargination with a small excision
 in the centre; ninth sternite with large V-shaped incision. Length
 15-17 mm. *truncorum* Meigen
32. Thoracic vittæ very wide; pleura with indistinct, brown spots. Pleural
 suture of hypopygium present, though indistinct. Posterior margin
 of ninth tergite yellowish, with two black, triangular, downward projecting
 processes on its under surface; posterior margin of ninth sternite
 with deep, rectangular incision. Whitish spots in all the cells.
 Length 20-33 mm. *pacificæ* Doane
 Mesonotum with six brown stripes; pleura gray with an oblique, brown
 stripe. Hypopygium without pleural suture or pleural plate; ninth
 sternite deeply and broadly emarginate. Length 20 mm. *subimera* Doane
33. Larger. Length over 20 mm. testaceous. *retorta* V. d. Wulp
 Smaller, not exceeding 16 mm. Grayish black; posterior margin of abdominal
 segments yellowish. Hypopygium large, blackish, appendages
 yellowish. Wings grayish-fuscous, base of first and fourth posterior
 cells, whitish. Length 11 mm. (γ) *ternaria* Loew
34. Thoracic vittæ margined. 35
 Thoracic vittæ not margined. 36
35. Joints of flagellum unicolorous. 47
 Joints of flagellum bicolorous. 47
36. A fuscous spot at end of longitudinal veins. 37
 Wings not so marked. 39
37. Larger, length 16 mm. and over. 38
 Smaller, length 10 mm. (σ^7). Brown; ninth tergite with a broad crescent
 shaped emargination. Ninth sternite with a very deep V-shaped incision.
 Neither pleural suture or pleural plates present. Basal half
 of fifth vein broadly bordered with fuscous anteriorly. Length 10
 mm. (σ^7) *simplex* †Doane

**olympia*, see under 93. *unicincta*, see under 138. *simulata* pratorum, see Appendix.

†*pubera* Loew., see 57; *rupicola*, see 50, and *abluta*, see 58, belong here.

‡The female has rudimentary wings and should have been placed under 165—species with rudimentary wings in the female—.

38. Thoracic dorsum with two velvety black spots each side behind the transverse suture. Fuscous spot at beginning of praefurca well marked. Abdomen orange-yellow above. Hypopygium small; neither pleural suture nor pleural plates; ninth tergite with a small semi-circular emargination in its posterior margin; ninth sternite with deep, oval emargination. Length 33-36 mm. *abdominalis* Say
 Thoracic dorsum not as above. The fuscous spot at beginning of praefurca inconspicuous. Abdomen tawny with fuscous median stripe. Hypopygium of moderate size; ninth tergite broadly emarginate in the middle and narrowly incised laterally on its posterior margin; posterior margin of ninth sternite with a deep V-shaped emargination. Length 20mm. (♀) *camuiscibitis* Doane
canlaminata Doane, sp. n.
39. One or more posterior cells at least in part white 40
 Posterior cells not at all white. Body blackish; abdominal segment tipped with pale. Wings brownish towards the apex, a white spot at the exterior margin, surmounted by a fuscous spot. Length 11 mm. (♀) *purii* Kirby
40. First posterior cell only, white at base. Pale ochraceous. Hypopygium large, ninth tergite rounded, black. Length 11 mm. (♂) *lutipennis* Loew
 More than one posterior cell white at base 41†
41. Lateral appendages of the ninth sternite (below the pleural appendages) without a lower pendulous, or claw-like arm. Hypopygium elongated, posterior margin of ninth tergite produced in the middle in a short, broad three pointed downward-projecting tooth; ninth sternite broadly emarginate posteriorly, from the middle of which arise two long strap-like appendages. Length 18 mm. *madera* Doane
 Lateral appendages with a lower pendulous, or claw-like arm 42
42. Lateral appendages with only two arms 43
 Lateral appendages with three arms 45
43. Lower arm of lateral appendage slender, membranous, nearly straight. Hypopygium large, ninth tergite with two pendulous processes at its posterior margin. Abdomen with a fuscous stripe each side. All posterior cells more or less white. Length 11½ mm. *fallax* Loew
 Lower arm of pendulous appendage more strongly chitinated, claw-like, tip blackish. 44
44. Lower arm of lateral appendages short, broad, flat. Grayish brown; pleura with an interrupted brown line running from neck to base of wings; postero-lateral margins of abdominal segments grayish. Eight sternite three-lobed; posterior margin of ninth sternite with downward projecting, three toothed process; two long, slender blade-like processes arise from the base of the incision of the posterior margin of the ninth sternite. Wings brownish with whitish hyaline spots in all the cells. Length 15 mm. *rohweri* Doane
 Lower arm of lateral appendages long, slender. Subtestaceous; first posterior cell almost entirely, fourth at base, white; ninth tergite without pendulous processes. Length 12-14 mm. *grata* Loew

*May not belong to the genus *Tipula*.

†The differentiation of the seven species under this heading, are based on the table given in Prof. Doane's paper, entitled "Tipula fallax and others." Psyche Vol. XIII, pp. 160-166. In wing pattern, they, together with *Tip. hebes*, resemble each other very much and *Tip. fallax* of the West and *Tip. hebes* of the East may be looked upon as typical.

45. The two upper arms of lateral appendages consist of two small, subequal, spine-like processes. Brown; pleura brownish; wing line running from upper angle of mesopleura to neck; above narrow, whitish brown, darker posteriorly; ninth tergite almost entirely black, with posterior lateral angles ending in short, blunt pointed processes; margin of ninth sternite with a pair of long, twisted, sickle-shaped processes. Wings brownish with a few whitish spots. Length 15 mm. (♂ and ♀) *cruciger* Doane
- First and second arms of lateral appendages very different in size and shape..... 16
46. The blade-like processes arising from the posterior margin of the ninth sternite long, slender, simous. Brown; pleura grayish with a brownish line reaching from neck to base of wing; abdomen yellowish brown with three interrupted, brown lines. Hypopygium small, elongated; extreme tip of ninth tergite produced downward into two short, sharp, curved claws; posterior margin of ninth sternite deeply notched and provided with two long, slender, sinuous, blade-like processes. Wings brownish with several whitish, heading pattern nearly all the cells wing pattern scarcely distinguishable from fallax—Length 15 mm. *fallax* Doane
- The blade-like processes shorter, more triangular. Brown; abdomen with broad median and narrow lateral stripes; ninth tergite a little longer than wide, posterior margin with a pair of short, black, downward projecting processes; ninth sternite completely divided, from the incision arises a pair of rather long, thin, sharp-pointed, blade-like processes; bases of first and fourth posterior cells whitish, distal cell almost wholly white. Length 13 mm. *neumert* Doane
47. First posterior cell white at base..... 18
First and fourth posterior cells white at base..... 19
First posterior cell not white at base..... 20
48. Smaller, 13-15 mm., ovipositor not serrulate beneath. Yellowish; pleura spotted with brown. Hypopygium large, ninth tergite large, longer than wide, narrowed posteriorly, its apex with a strongly chitimized, black, downward directed short, toothed process; ninth sternite with deep narrow incision, containing two long, slender, pointed, sickle-shaped processes; the lateral angle of the incision with a long, pendulous process. Length 13-15 mm. *hebes* Loew
- Larger, 21 mm. Testaceous; abdomen with three fuscous stripes, lamellae of ovipositor serrulate beneath. Wings grayish fuscous, fourth and fifth posterior cells somewhat paler at their base and along the vein separating the same. Length 21 mm. *serrulata* Loew
49. Color gray, median line of thorax not fusiform. Abdomen trivittate; wings grayish-fuscous, no white spots along posterior wing margin. Length 19½ mm. *dycolor* Loew
- Color yellow, median line of thorax fusiform. Abdomen trivittate, ultimate segments nearly black. Hypopygium small, ninth tergite very small, sub-orbicular; wings pale brown with about four whitish spots. Length 12 mm. *canadensis* Loew
50. Longitudinal veins fuscous at tip; femora with a whitish band a short distance before the tip. Brown; pleura grayish brown, with an irregular line and spots dark fuscous. Ninth tergite somewhat rounded, margin reflexed and with a pair of inconspicuous, black edged teeth; pleural suture complete, ninth sternite almost hidden by eighth sternite; posterior margin with two broad appendages. Length 25 mm. *rupicola* Doane
- Longitudinal veins not fuscous at tip, femora without preapical white band..... 51

*Type minus flagellum, joints of same may be unicolorous.

†Joints of flagellum toward the base pale brown, black at base, outer joints entirely dark fuscous.

‡Should have been placed under 37.

51. Dark cinereous; abdomen sordid testaceous, indistinctly trivittate, last two segments blackish, lateral margins of segments whitish. Hypopygium small, ninth tergite reniform. Wings grayish-fuscous, a small white spot at the posterior margin of the second basal cell, discal cell and base of fourth posterior cell indistinctly whitish. Length 14 mm.
centralis Loew
- Yellowish; thorax reddish; abdomen trivittate. Hypopygium moderately large, ninth tergite membranous posteriorly, deeply emarginate in the middle, sides deflected in the form of rounded lobes; ninth sternite entire, a somewhat ellipsoidal shaped process arises from its posterior margin. Wings strongly tinged with yellow. Length 10-24 mm. *flavescens* Fabr
52. Joints of flagellum unicolorous 53
Joints of flagellum bicolorous 60
53. Color grayish 54
Color not grayish 57
54. Three white spots along the posterior wing-margin; middle thoracic vitta obsolete anteriorly. Abdomen testaceous, lateral margins and last segments fuscous; hypopygium subcarinate below; wings grayish. Length 9-13 mm. *fragilis* ♂ Loew
suspecta ♀ Loew
- Posterior wing margin without three spots 55
55. Scutellum and metathorax shining; former yellow with a brown line in the middle. Abdomen brownish yellow, hind margin of segments and interrupted dorsal stripe brown; hypopygium rather large, ninth tergite broader than long, posterior margin with a crescent shaped emargination; ninth sternite nearly completely divided; pleural suture almost extending to the anterior margin. Wings pale gray, veins of apical portion white margined. Length 7-16 mm. *beatula* O. S.
Scutellum and metathorax not shining 56
56. Abdomen shining, sutures brown, wings with three clearly defined fuscous spots along the costal margin. Length 18 mm. *frigida* Walker
Abdomen trivittate; wings with three fuscous spots along the costal margin near the apex. Length 12 mm. *resurgens* Walker
57. Pubescens of body very conspicuous. Testaceous; thoracic stripes not very distinct. Hypopygium very large; ninth sternite large, barbed at the posterior margin with golden yellow hair. Wings grayish fuscous, anterior branch of second longitudinal vein abbreviated; most of the veins margined with fuscous; all posterior cells white margined. Length 18 mm. *pubera* *Loew
Pubescens of body not conspicuous 58
58. A whitish spot before and behind the stigma 59
Wings not so marked. Brown; mesonotum with four brown stripes; abdomen with lateral stripes, latero-posterior margins of segments yellowish; eight and ninth segments separated above by a deep furrow; lateral margins of ninth tergite drawn out into a blunt point posteriorly, ninth sternite divided by a deep quadrate incision. Veins in apical part of wing white margined, and tipped with fuscous; similar to *commiscibilis* (contaminata). Length 22 mm. (♀) *abluta* †Doane
59. The white spot before the stigma extends to base of fourth posterior cell; abdomen trivittate 60
The white spot before the stigma does not extend to the posterior cells. Brownish yellow. Mesonotum with four broad, brown stripes; abdomen with broken, brown lateral stripe; ninth tergite with deep, median furrow and rather deep V-shaped incision, the apex of which bears a short triangular black tipped tooth; ninth sternite with broad, deep U-shaped incision which contains a pair of large, tumid yellow haired appendages. Veins with indistinct whitish border. Length 16 mm. *californica* Doane

* Should have been placed under 37.

† Should have been placed under 37.

60. Yellow; mesonotum quadro-vittate. Hypopygium large, ninth tergite produced into two long flattened sub-triangular processes; ninth sternite produced laterally into rather long very acute triangular appendages. The white spot extends through the fourth posterior cell to the posterior margin. Length 17 mm. ($\frac{1}{2}$). *arabata* Doane
- Brown; mesonotum with three brown stripes; pleura slate-colored. Posterior margin of abdominal segments paler; posterior margin of ninth tergite depressed shining black with median, short blunt process; ninth sternite with rounded emargination, containing a pair of rather long, tumid appendages. Wings gray with three conspicuous, white spots. Length 15-23 mm. *albomaculata* Doane
61. Abdomen pale yellowish, posterior margin of segments dark fuscous. *trivittata* Loew 62
- Abdomen not so marked.
62. Gray; ovipositor with a large, oval piceous and shining shield above, terminated by two movable, lanceolate, serrated and ferruginous lobes; penultimate joint (of abdomen) with two long, slender spines beneath; length 21-22 mm. *arctica* Curtis
- Not gray; ovipositor not so constructed. 63
63. Fuscous; abdomen ferruginous with two fuscous stripes; thorax with pale brown stripes. Wings brownish with several whitish spots and three fuscous spots near the costal margin. Length 16 mm. ($\frac{1}{2}$). *platamera* Walk
- Yellowish species; abdomen trivittate. 64
64. Thorax grayish, or yellowish gray; all the joints of flagellum bicolorous. Hypopygium very large, pleural pieces greatly elongated, linear. Three or four fuscous spots near the anterior margin, fourth and fifth posterior cells partly white. Length 13-14 mm. *maculabasis* Loew
- Mesonotum light yellow with four brown stripes. Ninth tergite ($\frac{2}{3}$) nearly concealed beneath the eight. Wings tinged with brown, a brown spot in the anterior margin of first basal cell, origin of pterofurca and over the stigma, an incomplete whitish band before the stigma extends to base of fourth posterior cell. Length 19 mm. ($\frac{2}{3}$). *aria* Doane
65. Joints of flagellum bicolorous. 66
- Joints of flagellum unicolorous. 66
66. Cinereous, thoracic vittae distinct. 67
- Yellowish, thoracic vittae concolorous, indistinct; apical third of wing infusate. 68
67. White spots at end of veins; mesonotum with two brown lines, confluent anteriorly; wings dusky, three or four white spots along central vein, stigma margined white; abdomen blackish; apex of femora blackish. *maculipennis* Say
- No white spots at end of veins; thoracic stripes margined; abdomen yellowish-gray with three dark stripes, hypopygium small, ninth tergite small, ovate; ninth sternite absent (?). Wings pale fuscous, with four pale spots; base of first and fifth posterior cells white. Length 14 mm. *abuloptera* Loew
68. The white spot before the stigma extends across the wing and attains the posterior margin. Hypopygium large, ninth tergite broadly and profoundly emarginate, the lateral angles extended into sharp points; ninth sternite nearly concealed by the large, protuberant eighth sternite, pleural plates present, small, the lower angle of the right pleural plate prolonged into a two pronged process. Length 17 mm. *speciosa* Loew
- The white spot does not extend beyond the base of the fourth posterior cell. Smaller, and wings paler than in *speciosa*. Length 15-16 mm. *submaculata* Loew

*See also under 20.

†See under 16.

‡Type specimens minus antennae.

§Indistinctly seen in *T. valida*, Loew; antennae wanting in *T. versicolor*.

69. Thoracic stripes not margined.....70
 Thoracic stripes margined.....70
70. Apical third of wing infusate; yellowish-gray; abdomen trivittate; lateral margin and posterior margin of segments whitish; ovipositor with a semi-tubular process each side at base. The white spot in front of the stigma extends across the wing and attains the posterior margin; base of third posterior cell white. Length 19-20 mm.....
valida Loew
- Apical third of wings not infusate.....71
71. Abdomen black or orange colored.....72
 Abdomen not so colored.....73
72. Abdomen blackish, posterior margin of segments yellow. Black; hypopygium small, posterior margin of ninth tergite depressed with two median, longitudinal, shining black ridges; ninth sternite with a broad deep incision. Wings grayish-brown, rhomboidal, discal and fourth posterior cells almost wholly white. Length 14 mm. (♂).....
helzeincta Doane
- Abdomen orange-yellow with three black, longitudinal stripes. Wings brownish, yellowish toward the costa, with about four whitish spots, first and fourth posterior cells whitish at base. Length 15½ mm. (♀).....
versicolor Loew
73. Posterior cells not at all white. Head and thorax blue-black; stripes of latter indistinct; abdomen brownish yellow, first segment black, with brown lateral stripes; ninth tergite with broad, deep, crescent shaped incision; ninth sternite with deep, V-shaped incision, almost separating the segment; pleural plates distinct. Wings with four indistinct, whitish spots. Length 16 mm. (♂).....
nigrocorporis Doane
- One or more posterior cells at least partially white.....74
74. Abdomen with median stripe. Brown; thorax with five stripes, § lateral pair confluent before and behind; a lateral black spot on each abdominal segment; whitish spots along costal border distinct, those of disc indistinct, a small brown spot near the tip. Length 20 mm.....
dorsimacula Walker
- Abdomen without median stripe.....75
75. Posterior cells one and four white at base. Pale ochreous. Hypopygium moderate, ninth tergite short with two linear processes in the middle of the posterior margin, eight sternite protuberant, emarginate at apical margin and with lateral, leaflike process each side; ninth tergite with apical V-shaped emargination, pleural suture short. Wings grayish, apex a little darker, with about four not very distinct, whitish spots. Length 12 mm.....
pallida Loew
- First posterior cell only, white at base. Grayish; thorax grayish white. Wings with several whitish spots. Length 12 mm. (♀).....
ignobilis Loew

**T. impudica* see 121.

†Mr. C. P. Alexander informs me that he has seen the type of *T. valida*, a female, in the Loew collection at Cambridge and that it is identical with specimens of *T. calva*, in my collection, determined as such by Prof. Doane. The type of the latter species was a male. Specimens of both species—determined as such by Prof. Doane and Mr. C. P. Alexander respectively—apparently agree in all particulars, except in coloration of the flagellar joints, which are distinctly bi-colored in *calva* and nearly fuscous in *valida*. There is also a difference in the apical appendages of the two species. Loew does not mention the narrowly infusate posterior transverse, and apical posterior of fifth veins.

‡Type, a female, minus antennæ.

§ In all probability it should read: thoracic stripes concolorous, margined.

76. Posterior cells one and four white at base. Yellowish; abdomen with three fuscous stripes; hypopygium small; ninth tergite nearly divided, lobes rounded, posterior margin of each bidentate, ninth sternite with deep V-shaped emargination, containing two hairy pendulous appendages. Wings brownish with about four conspicuous, whitish spots. Length $14\frac{1}{2}$ -18 mm. *verta* Loew 77
- Posterior cells one and four not white at base. 77
77. First and fifth posterior cells white at base. Brown; mesonotum with four brown stripes; abdomen with narrow lateral stripes; hypopygium small, ninth tergite terminating in a median, short and rather acute point. Wings grayish with faint, whitish spots; stigma surrounded by white, a large white spot covers tips of basal cell and base of discal and fourth and fifth posterior cells. Length 14 mm. *submaculosa* Deane 78
- First posterior cell only, white* at base. 78
78. Wing spots distinct, posterior margin of wing not white; leg. robust. Abdomen trivittate; hypopygium not large, ninth tergite short, broad, emarginate posteriorly, ninth sternite broadly and very deeply emarginate, the emargination filled by a membrane, from the posterior border of which arises a slender process which ends in two large, fleshy lobes, which are emarginate at the apex. Wings brownish, a large whitish spot, common to anal and axillary cells. Length $14\frac{1}{2}$ mm. *angustipennis* Loew 79
- Wing spots very indistinct, posterior margin of wings whitish; leg. slender; thoracic vittae subconfluent; abdomen with black, median stripe; hypopygium large with two large, pendulous appendages. Length $7\frac{1}{2}$ mm. *appendiculata* Loew 80
79. Joints of flagellum unicolorous. 80
- Same as all the joints of flagellum bicolorous. 81
80. Pleura without oblique, fuscous stripe. Brown; mesonotum with three grayish-brown fuscous bordered vittae, abdomen with broad, interrupted, brown lateral stripes, lateral margins of ninth tergite produced into short, blunt points, posteriorly; all posterior cells margined with brown. Length 16 mm. (?) *fulvulinata* Deane 82
- Pleura with oblique fuscous stripe. Yellowish; posterior border of abdominal segments whitish; discal cell subovate, first posterior cell without subhyaline stripe. Length 13 mm. (?) *subulna* Johnson 83
81. Median vitta of wing attains the apex. 82
- Median vitta of wing does not attain the apex. 83
82. Costal stripe sinuous posteriorly. Thoracic stripe not sharply demarcated; abdomen with lateral fuscous stripes; hypopygium small, ninth tergite rounded posteriorly with a rounded, median process terminating in posterior margin, ninth sternite with a very deep V-shaped notched second posterior cell small, fourth and fifth white at base. Length $12\frac{1}{2}$ -16 $\frac{1}{2}$ mm. *alba* Loew 84
- Costal stripe not sinuous posteriorly. 84
83. The hyaline vitta of the wing passes through the first posterior cell to the apex; abdominal segments without dark fuscous transverse line before the posterior margin, the latter and lateral margin of segment paler. Length 14 mm. (?) *clata* Loew 85
- Hyaline vitta does not pass through the first posterior cell to the apex; dark transverse line before the posterior margin of the abdominal segments 85

*In the male of *angustipennis* this cell is frequently not white.

84. Larger, 20-28 mm; costal border broader and more deeply fuscous; the median vitta begins about the middle of the second basal cell, basal half of anal and axillary cells whitish hyaline. Hypopygium small, exposed part of ninth tergite short, posterior margin with a median broader and two lateral, clawlike processes, ninth sternite divided to near its base by a narrow suture, posterior margin sub-triangularly emarginate, the lateral angles end in a scroll-like protuberance, pleural suture present. Length 19-25½ mm. *caloptera* Loew
Smaller, 19-20 mm. Costal border less intensely fuscous, the median vitta begins near the base of the second basal cell; anal and axillary cells grayish fuscous, slightly paler at the base. Hypopygium small, ninth tergite produced posteriorly into a large, lobelike process, almost as long as the exposed part of the body of the segment, ninth sternite deeply divided to near its base; pleural suture present. Length 14-20 mm. *strepsis* Loew
85. The white spot before the stigma extends across the wing in form of an irregular fascia and nearly reaches the posterior margin; part of costal border posterior to subcostal cell, paler. Length 13 mm. (♀) *fraterna* Loew
The white spot does not extend beyond the base of the fourth posterior cell. S6*
86. Abdomen without fuscous stripes; hypopygium small, ninth tergite produced posteriorly into a large, lobe-like process, at each side of the posterior margin arises a pencil of long, stiff bristles, ninth sternite deeply and rather widely divided to near its base; pleural suture present. Length 12-20 mm. *tricolor* Fahr
Abdomen with fuscous, lateral stripes. Length 15½ mm. (♂) *vitrea* V. d. Wulp
87. All the veins with a more or less distinct brown border. Gray, thoracic vittae bordered with fuscous; abdomen fuscous; eight sternite distended by a tumid appendage on the ventral side of the ninth sternite, the latter with deep V-shaped incision and median suture; pleural plates present; posterior margin of ninth tergite with two close-set, black tipped projections. Wings almost hyaline with an indistinct whitish stripe in the first basal cell. Length 11 mm. *meridiana* Doane
Not all the veins bordered with fuscous. S8
88. Posterior cross vein and apical part of fifth longitudinal vein narrowly bordered with fuscous. S9
Posterior cross vein and apical part of fifth vein not so marked. 94
89. Thoracic stripes margined with fuscous. Brown; joints of flagellum unicolorous, dark brown; abdomen with lateral fuscous stripes, hypopygium rather large, black, no pleural suture or pleural plates, posterior margin of ninth tergite with two slender processes. Ninth sternite with deep, broad incision and median yellow line. Wings almost hyaline, the indistinct whitish band in front of the stigma, extends to base of fourth posterior cell. Length 17 mm. (♂) *albocaudata* †Doane
Thoracic stripes not margined. 90
Color yellow. 91
Color fuscous. 92

*No mention of "a white spot before the stigma" is made by the author of *T. vitrea*.

†Specimens in my collection determined by Prof. Doane and agreeing with his description, show a well marked, strongly curved pleural suture.

91. Abdomen with more or less distinct fuscous stripes; lateral margins of segments broadly whitish. Joints of flagellum bicolorous. Hypopygium large, eighth sternite truncate, the posterior margin with a median broad, rectangular process, lateral angles with a pair of long, rather narrow, flattened appendages; ninth tergite prolonged into two long, blunt processes; ninth sternite nearly concealed by the eighth sternite; pleural plates distinct, but pleural suture nearly obliterated above. The white spot before the stigma extends to base of fourth posterior cell. Length 21 mm. (♂). *valida* Doane
- Abdomen not striped longitudinally, posterior margin of segments yellow. Joints of flagellum approximately unicolorous, brown; posterior border of eighth sternite emarginate with two bunches of reddish yellow hair; ninth tergite produced and narrowed posteriorly, posterior margin with crescent-shaped incision, with a median pair of short, black triangular downward projecting teeth; ninth sternite divided by a membranous area, posterior margin with two pairs of small appendages. Wings hyaline, the white antestigmatic band reaches almost to the posterior border. Length 11 mm. *laemarginata* Doane
92. Small cross vein margined with fuscous; flagellum dark brown; abdomen with two broad dark brown stripes, lateral and posterior margins of segments grayish; the posterior lateral corners of the ninth tergite drawn out into a short blunt process. (♀); Wings almost hyaline, hypopygium similar to that of *albocaudata*. Length 19 mm. *cegnata* Doane
- Small cross vein not margined with fuscous. 93
93. A spot over the base of the second submarginal and first posterior cells and a spot over the origin of the prefurca brown. Flagellum brown; mesonotum with four darker brown stripes, ninth tergite terminating into two short blunt processes. Wings with a brownish tinge. Length 15 mm. (♂). *olympia* Doane syn. *carolina* Doane
- Without spots over base of second submarginal and first posterior cells and over origin of prefurca. Joints of flagellum unicolorous; mesonotum with three brown stripes; posterior lateral angles of eighth sternite with large appendages; posterior margin of ninth tergite with rounded incision, in the middle of which are two short, sharp points; ninth sternite divided by a deep, broad, U-shaped incision, containing a pair of pendulous appendages; pleural suture complete. Length 15 mm. (♂), 23 mm (♀). *angulata* Doane
94. Wings with dark costal stripe. 95†
- Wings without such a stripe, though costal margin may be a trifle darker than the rest of the wing. 99
95. Joints of flagellum bicolorous; costal stripe margined posteriorly by a subhyaline stripe. Abdomen dark yellowish, segments with a short, transverse fuscous line behind the anterior margin of segments 3-6 and a very small fuscous dot on the sides of all segments; hypopygium small, ninth tergite rounded posteriorly, impressed before and slightly notched in the middle of the posterior margin; ninth sternite compressed in its basal half into a carina; pleural suture distinct. Length 13-16 mm. *costalis* ‡ Say.
- Joints of flagellum not distinctly bicolorous, outer joints at least fuscous. Abdomen with fuscous stripe. 96
96. Costal stripe interrupted before the stigma by an indistinct hyaline spot. Length 19 mm (♀) *cunctans* Say.
- Costal stripe not interrupted. 97

*See foot note on *valida*, under 70.

†*T. clara* probably belongs here. See 103.

‡Because *costalis* being preoccupied in the genus *macramaxitix*, Mr. C. P. Alexander has changed *T. costalis* to *T. Sayi*, a view which I cannot share, hence shall here retain Say's name.

97. Gray, posterior margin of abdominal segments grayish-brown. Hypopygium moderately large, ninth tergite broadly and deeply emarginate, the margin notched in the middle, lateral angles produced into a process, subtruncate at the apex, ninth sternite deeply divided by a U-shaped incision, the latter containing a medium lobe-like process, lateral margins of the incision emarginate, the upper angles bearing a long pendulous process. Wings light grayish fuscous. Length 14½-15½mm *infuscatula* Loew
98. Not gray, posterior margin abdominal segments not paler 98
 Reddish yellow, smaller. Head and thorax whitish pollinose. Hypopygium very small, compressed. Wings pale fuscous, first basal cell and margin of second a trifle paler. Length 13mm (♂) *casta* Loew*
 Brown, larger. Thorax gray with four brown stripes; posterior margin of eighth sternite† with a median tuft of yellow hair between a pair of irregularly shaped, six-sided, box-like appendages; ninth tergite with the posterior-lateral angles produced into two broad, truncate projections; posterior margin of ninth sternite with rounded incision containing a pair of horn-like projections. Length 16-20mm *flavocauda* Doane
99. A vitreous spot before the stigma 100
 Without such a spot 154‡
100. Spot lunate, extending to or beyond the discal cell 101
 Spot small, never extending beyond the second longitudinal vein 115
101. Joints of flagellum distinctly bicolorous 102§
 Joints of flagellum approximately unicolorous 110
102. Fuscous species; abdomen with three darker stripes; eight sternite with a median process 103
 Yellowish species, costal and subcostal cells yellowish 104
103. Costal and subcostal cells brown. Mesonotum with four darker vittae; posterior margin of abdominal segments paler; ninth tergite short, incised in the middle. Wings hyaline, anterior margin of anal cell fuscous, the whitish line before the stigma which extends into the base of the fourth posterior cell, very indistinct. Length 16-22mm *pellucida* Doane.
clara ||Doane, Syn.
- Costal, subcostal and anterior margin of anal cells tinged with yellow. Mesonotum with three dark vittae; lateral and posterior margins of abdominal segments paler; hypopygium small, ninth tergite with deep crescent-shaped incision, ninth sternite with deep U-shaped incision, which contains two long, tumid appendages. The white spot before the stigma reaches the extreme base of the fourth posterior cell. Length 20-27mm *inermis* Doane.
104. Abdomen with three dark, fuscous stripes, valves of ovipositor short, blade-like 105
 Abdominal stripes, if any, faint; if distinct, but one dorsal stripe 106
105. Posterior margin of ninth tergite with a short, rather broad, two pointed process, posterior margin of eighth sternite with fringe of yellow hair and two strong, curved reddish bristles; ninth sternite with median depression, in which lie the tips of two short appendages; the white spot before the stigma reaches the posterior border of the discal cell. Length, 15-18mm *megaura* Doane.

* Probably the male of *cunctans* Say., and according to Osten Sacken, synonymous.

†Original description says, "tergite," evidently a misprint.

‡Not infrequently the space before or surrounding the stigma is paler than the general color of the wing.

§Antennae of *T. clara* not described by its author.

||Prof. Doane does not mention the antennae.

- Posterior margin of ninth tergite with a small, submedian median emargination, the external posterior angles extend as upturned, hornlike processes, ninth sternite nearly concealed by the eighth, bearing on each lateral posterior angle an incurved, clawlike process. The white spot scarcely reaches the extreme base of the fourth posterior cell. Length 12 mm. *Lecontei* Loew M.
106. Thoracic vittae and dorsal stripe of abdomen distinct; length 10 mm. *paucicornis* Macg.
- Thoracic vittae obsolete or indistinct. 107
107. Joints of flagellum fuscous, yellow at the base; a transverse fuscous line before the posterior margin of the abdominal segment; abdomen with lateral fuscous stripe; white ante-stigmal spot very distinct; lat. extends as a very faint line to discal cell. Ninth tergite quadrate, posterior margin slightly emarginate in the middle with two central, digitiform processes; ninth sternite small; pleural suture present. Length 12-18 mm. *tephrocephala* Loew
- Joints of flagellum yellow, fuscous at the base; abdominal segments without transverse striae before the posterior margin; lateral angle of eight sternite with a single or a pencil of two or three setae; lateral angle of ninth tergite ending into a sharp point. 108
108. Thoracic vittae obsolete; posterior margin of abdominal segments gray; the white ante-stigmal spot does not enter the fourth posterior cell. Length 15 mm. (♂). Ninth sternite emarginate, the emargination containing two pendulous processes. *translucida* Doane
- Thoracic vittae not obsolete, though indistinct; posterior margin of abdominal segments not paler. 109
109. The white ante-stigmal spot does not reach the posterior margin of the discal cell. Ninth sternite as in *translucida*, no white spot beyond the stigma. Length 16 mm. (♂). *cincticornis* Doane
- The white ante-stigmal spot extends into the base of the fourth posterior cell. Ninth sternite as in *translucida*; a white spot beyond the stigma. Length 15-17 mm. *cuspidata* Doane
110. Yellowish species 111
- Brownish-yellow species 124
- Grayish or fuscous species 129
- Blackish species (Northern). 142
111. The ante-stigmal spot does not extend into the discal cell. Mesonotum with three broad, dark brown vittae; abdomen trivittate; eight sternite produced and narrowed posteriorly; ninth tergite very small, produced into two blunt processes posteriorly; ninth sternite large, lateral angles produced into long, tapering, twisted, hornlike processes. Length 13-14 mm. *streptocera* Doane
- The ante-stigmal spot extends into or across the discal cell. 112
112. Posterior margin of some or all abdominal segments paler. 113
- Posterior margin of abdominal segments not paler. 118
113. Posterior margin of all the segments paler. 114
- Some segments without pale posterior margin. 117
114. Abdomen with three well marked brown stripes. Mesonotum with five brown lines; joints of flagellum brown, darker at the base; lateral angles of eight sternite with two incurved reddish bristles; ninth tergite with deep broad, crescent-shaped incision; ninth sternite with deep V-shaped incision, below which is a whitish, oval process. Wng. hyaline ante-stigmal spot very indistinct, but reaches the base of the fourth posterior cell. Length 18-22 mm. *bisetosa* Doane
- Abdomen yellow, darker posteriorly but without longitudinal stripes; flagellum brown; ninth tergite with deep V-shaped incision. 115
- Abdomen reddish yellow, three indistinct stripes. *T. lamellata*, see 119.

115. Abdominal segments 6-8 mostly black. Mesonotum trivittate; ninth sternite with deep incision, containing a pair of yellow appendages; wings hyaline, a faint brown spot over origin of praefurca, ante-stigmal spot broad, distinct, reaches base of fourth and side of fifth posterior cell. Length 15-20 mm. *retusa* Doane
116. Abdominal segments 6-8 not black. 116
Mesonotal stripes and ante-stigmal spot distinct. Eighth sternite very large with median, rectangular projection of the posterior margin; ninth sternite with deep U-shaped incision, containing a long, rather broad tumid process; pleural plates distinct; fifth vein narrowly bordered with brown. Length (σ^7) 22 mm. *spulha* Doane
Mesonotal stripes and ante-stigmal spot very indistinct. Eighth sternite long, narrowed posteriorly; posterior margin of ninth sternite with two processes, each bearing a tuft of hair, lateral margins with two pairs of appendages. Length (σ^7) 12 mm. *splendens* Doane
117. Ante-stigmal spot extends to posterior margin of wing; posterior margin of abdominal segments 1-7 pale yellow. Joints of flagellum brown, yellow at the base. Mesonotum with three broad, reddish brown stripes. Abdomen trivittate, segments 8-9 wholly brown. Wings nearly hyaline. Length (σ^7) 20 mm. *albofascia* Doane
Ante-stigmal spot does not reach the posterior margin of wing. Abdomen with three stripes, posterior margin of segments 4-8 white; ninth tergite with deep, median impression bearing at its end a rather broad, sharp pointed process; ninth sternite with deep, white bordered incision which contains two pendulous appendages. Wings hyaline, a whitish spot beyond the stigma and two whitish, indistinct streaks just behind the sixth longitudinal vein. Length (σ^7) 19 mm. *albocincta* Doane
118. A whitish spot beyond the stigma. Joints of flagellum darker at the base; three broad mesonotal stripes; three indistinct abdominal stripes; lateral angles of eighth sternite with a pair of rather broad appendages; ninth tergite thick swollen with median shallow furrow, posterior margin produced each side into a blunt, swollen process, deeply emarginate between the processes; ninth sternite with rounded incision which is filled by two long triangular appendages. Wings hyaline; the ante-stigmal spot extends into the base of the fourth posterior cell. Length 21 mm. (σ^7). *hirsuta* Doane
Without whitish spot beyond the stigma. 119
119. Mesonotal vitta obsolete or very faint; abdominal stripes and ante-stigmal spots ill defined or indistinct. 120
Ante-stigmal spots at least distinct. 121
120. Larger, 18-20 mm., thorax yellow, shining, no stripes. Flagellum brown; posterior margin of eighth sternite* with two tufts of long hair; hypopygium large; posterior margin of ninth tergite with slight median incision, lateral angles produced into short, slender acute points; ninth sternite with rather deep incision containing a pair of short appendages. Wings hyaline. *lucida* Doane
Smaller, 12-13 mm. Flagellum brown; thorax not shining, stripes very faint brownish. Ninth tergite nearly completely divided, each side terminating into a point, bent at right angle to upper surface. Ninth sternite long, posterior margin with two small processes, each bearing a tuft of hair. Wings hyaline. *lamellata* Doane
121. Abdomen with three black stripes; ante-stigmal spot distinct; flagellum dark fuscous. 122
Abdomen without such stripes; thoracic stripes very faint; ante-stigmal spot distinct extending to base of fourth basal cell. 123

*In the description it says "tergite," no doubt by misprint.

122. Ante-stigmal spot extends into the bases of the fourth and fifth posterior cells, one or two irregular whitish hyaline spaces in anal and axillary cells. Mesonotum with four brown lines; posterior margin of abdominal segments gray; ninth tergite short, divided by deep median incision; ninth sternite with deep, median incision. Wings with grayish tinge. Length 15-25 mm. *impudica* Doane
- Ante-stigmal spots extends into fourth posterior cell only; no hyaline spots in anal and axillary cells. Mesonotal vitta very distinct; ninth tergite rather short, with deep broad, V-shaped emargination; ninth sternite with triangular emargination, the anterior end of which is almost circular; eight sternite with nearly semi-circular emargination; pleural plates distinct. Length 13-18 mm. *praeusta* Loew
123. Joints of flagellum light brown, darker at the base; eighth sternite not emarginate. Ninth tergite with median furrow, lateral angles slightly produced; ninth sternite divided by a rather wide membranous portion, posterior margin with a pair of two parted appendages. Wings hyaline. Length 12 mm. *rusticola* Doane
- Joints of flagellum fuscous; eighth sternite with shallow, broad rounded incision. Hypopygium large, ninth tergite of moderate length, narrowly emarginate in the middle, apical margin of each side very slightly emarginate; ninth sternite widely and very deeply emarginate, with a broad, subtriangular process each side. Length 18 mm. *biarmata* Doane
124. Posterior margin of abdominal segments paler. 125
- Posterior margin of abdominal segments not paler; abdomen more or less distinctly trivittate. 126
125. Mesonotum yellowish with three broad brown stripes; median fuscous vitta of abdomen broad; posterior margin of eighth sternite with two median short projections; median third of ninth tergite yellow, rest brown, with broad, deep incision and median depression; ninth sternite with very broad, deep U-shaped incision, lateral margin with a pair of short processes; pleural plates distinct, produced into a long, two pointed process; ante-stigmal spot indistinct and does not reach the base of the fourth posterior cell. Length 9-11 mm. *nitrosomus* Doane
- streptocera* Doane, see under 111.
- impudica* Doane, see under 122.
- fulvifrons* Doane, see under 110.
- albicincta* Doane, see under 117.
126. Mesonotum with four brown stripes; eight sternite produced, not emarginate; with a rather broad, elongated round tipped flap; ninth tergite short, divided by a deep V-shaped incision; ninth sternite elongated, deeply incised, lateral margin with long, slender pointed process. Ante-stigmal spot broken, extends into base of fourth posterior cell. Length 19 mm. (♂). *pyramus* Doane
- Mesonotum with three or five brown stripes or lines; eighth sternite emarginate at apex; ninth sternite deeply divided. 127
127. Ninth tergite small, bi-emarginate at the apex. Mesonotum with three brown stripes; scutellum yellow with median brown line; emargination of ninth sternite filled with two appendages, each terminating in a pair of backward projecting claws. Wing hyaline with light brownish tint, stigma inconspicuous; ante-stigmal spot distinct, extends into the base of the fourth posterior cell. Length 18-27 mm. *planicornis* Doane
- Ninth tergite broadly or deeply emarginate; ante-stigmal spot reaches the base of the fourth posterior cell. 128
128. Mesonotum with three broad, brown stripes; ante-stigmal spot distinct; abdominal stripes indistinct. Emargination of eighth sternite very broad, rounded; posterior margin of ninth tergite with broad and shallow emargination, the latter with yellow border and bearing in the middle a pair of blackish, triangular teeth; emargination of ninth sternite U-shaped and containing a pair of toothed appendages. Length (♂) 16 mm. *glyptocera* Doane

- Mesonotum cinereous, with three median brown lines and two lateral, broader brown stripes; ante-stigmal spot very faint. Emargination of eighth sternite very slight, rounded; emargination of ninth tergite very deep, V-shaped, latero-posterior angles sharp-pointed; lower angle of pleural plates produced into a short, blunt point. Length 12-15 mm. *biuncus* Doane
129. Posterior margin of abdominal segments paler. 130
- Posterior margin of abdominal segments not paler. 137*
130. With whitish spot beyond the stigma. 131
- Without such a spot. 133
131. Ante-stigmal spot extends through discal, fourth and fifth posterior cells to the posterior margin of the wing. Mesonotum cinereous with five brown stripes; three abdominal stripes, lateral one broader, base of first segment whitish; eighth sternite produced, slightly emarginate at the apex; ninth tergite small with broad, V-shaped emargination bordered posteriorly by a yellowish, less coriaceous margin; ninth sternite deeply divided, lateral margin angulated in such a way, that the emargination is widest at the base and narrowed about the middle. Length 12-14 mm. *usitata* Doane
- Ante-stigmal spot does not reach the posterior margin; thorax trivittate. 132
132. Mesonotum light brown; abdomen with three longitudinal, brown stripes. Posterior margin of eighth sternite broadly emarginate, the posterior margin with a fringe of thick, long, yellow hair; ninth tergite with narrow, median incision; posterior margin of ninth sternite whitish with deep median incision, on each side of which are two small appendages. Ante-stigmal spot indistinct, extends into the base of the fourth posterior cell, discal cell four times as long as wide. Length 13-14 mm. *barbata* Doane
- Thorax gray; abdomen without longitudinal stripes. Scutellum dark yellow; eighth sternite simple, not emarginate; hypopygium small, somewhat compressed laterally, ninth tergite small with V-shaped emargination; ninth sternite widely and very deeply divided and from the base of the emargination arises a median, digitiform, hairy process, directed horizontally backwards. Wings yellowish hyaline, veins brown, the ante-stigmal spot is inconspicuous and extends into the base of the fourth posterior cell. Length 10-14 mm.
- *aropesoides* Johnson
133. Eighth sternite deeply divided; abdomen with three stripes. 133
- Eighth sternite not emarginate. 135
134. The lateral margins of the eighth tergite end in long, slender processes; a broad blunt process arises from the base of the emargination. Mesonotum with four brown stripes; abdominal stripes indistinct; ninth tergite terminates in two short, median blunt processes; ninth sternite with deep U-shaped incision. The ante-stigmal spot distinct, interrupted at the praefurca, extends into the base of the fourth posterior cell. Length 15 mm. *calcarata* Doane
- Lateral margins of eighth sternite do not end in long processes; from the emargination arise two tufts of hair; ninth sternite deeply incised. 135
135. Mesonotum with four distinct stripes; ninth tergite with broad, shallow emargination. Abdominal stripes indistinct anteriorly, lateral margins of segments gray. Ante-stigmal spot extends into the base of the fourth posterior cell. Length 15-21 mm. *aegualis* Doane
- Mesonotum with three brown stripes; ninth tergite with broad, deep V-shaped incision. Abdominal stripes more distinct; ninth sternite with broad, deep depression; pleural suture very short. Ante-stigmal spot indistinct, extends into the base of the fourth posterior cell. Length 9 mm. (♂). *alta* Doane

*Except fulvinodus, see under 140.

136. Mesonotum with three broad stripes; posterior margin of eighth sternite with two short acute processes; posterior margin of ninth tergite with narrow median and two broader crescent shaped incisions; ninth sternite with deep U-shaped incision, containing two tumid appendages. Ante-stigmal spot indistinct, not entering the fourth posterior cell. Length (σ^7) 15 mm. *subtilis* Doane
- Mesonotum with four, rather broad stripes; eighth sternite with a median rather broad process. Ninth tergite short, incised in the middle; ninth sternite with deep and rather broad incision. Wings hyaline; costal, subcostal and the anterior margin of the anal cells and stigma, brown; ante-stigmal spot indistinct, extends into the base of the fourth posterior cell. Length 16-22 mm. *clara* Doane, syn. *pellucida* Doane. (See also under 103.)
137. Small, 10 mm., general reddish-brown color; thoracic stripes obsolete. Posterior margin of segments and last three segments of abdomen dark brown. Wings light brown, veins dark brown; ante-stigmal spot reaches the posterior side of the discal cell. *jeana* Johnson
- Generally larger species, color fuscous or gray. 138
138. Whitish streaks in anal, axillary and 2-5 posterior cells; a fuscous spot on basal transverse vein. Mesonotum with four striped abdomen with three rather indistinct lines; posterior margin of eighth sternite with a small appendage, lateral angle with a pair of larger appendages; ninth tergite ending in two rather acute points. Wings brownish tinted, ante-stigmal spot extends into base of fourth and side of fifth posterior cells. Length 19-22 mm. *annulata* Doane
- Wings without whitish streaks, no fuscous spot on basal transverse vein. 139
139. Eighth sternite incised. 140
140. No white spot beyond the stigma; ninth tergite with two small crescent-shaped incisions. Brown; mesonotum with three broad brown stripes; scutellum and metanotum with narrow brown line; abdomen trivittate; lateral margin of the emargination of the eighth sternite with a pair of broad, two pointed appendages; ninth sternite divided, posterior lateral angles with a pair of elongated appendages, which again are provided with a pair of slender, long, twisted and pendulous appendages. Wings with brownish tinge, ante-stigmal spot extends into the base of the fourth posterior cell. Length 19-21 mm. *acuta* Doane
- A white spot beyond the stigma, posterior margin of ninth tergite with Y-shaped incision. Mesonotum with three brown stripes, each of which is divided by a gray line; abdomen trivittate, posterior margin of segments yellowish; ninth sternite with rounded incision, containing a pair of whitish appendages. Wings hyaline, ante-stigmal spot very faint, broken, extends into base of fourth posterior cell. Length 12 mm. *fulvipes* Doane
141. Gray, mesonotum with three vittae the median indistinct, a median yellow line from transverse suture to base of abdomen, anterior margin of segments of the latter paler. Hypopygium small. Wing, hyaline, with slight grayish tinge, very faint lighter streak, in nearly all the cells, stigma surrounded by an indistinct whitish disk, which is incompletely connected with a whitish spot in the base of the discal cell. Length 10-14 mm. *dorsellucata* Doane
- Fuscous; mesonotum with five, rather broad stripes, lateral one connected anteriorly; abdomen trivittate; eighth sternite large, posterior margin bearing two pairs of appendages; hypopygium large; median of ninth sternite contains a pair of rather long, somewhat curved, tumid, pendulous appendages. Wings with light brownish tinge, ante-stigmal spot extends into base of fourth posterior cell. Length 14-17 mm. *ansulata* Doane

*No stripes mentioned in the description.

†Should have been included under 125.

142. Antennae long, reach base of third abdominal segment (σ^7); front and occiput with median black line.....143
 Antennae of male do not reach beyond the base of the abdomen; front and occiput without median black line.....141
143. Joints of flagellum of male very slightly constricted in the middle, three mesonotal vittae, margined with black; abdomen with black stripe each side. A yellow stripe extends from below the humerus to base of wing and scutellum; margins of median thoracic vittae widely diverging anteriorly; margin and lower side of scutellum yellowish; hypopygium large; eighth sternite with black hair; posterior margin of ninth tergite with a pair of conical, blunt processes. Wings pale gray, the ante-stigmal spot not connected with the discal spot; a spot beyond the stigma. Length 14-18 mm.....*strigata* Coq
 Joints 4-7 of male flagellum, strongly constricted in the middle; lateral vittae of mesothorax obsolete, the median stripe gray, bordered with black; Abdomen sparsely clothed with short, pale yellow hair, yellow with median black vitta; hypopygium rather small, eighth sternite with sparse, short yellowish hair; ninth tergite without apical processes. White spots of wing indistinct. Length 11-13 (σ^7) to 15-19 (σ^7) mm.....*cineracea* Coq
144. Thorax with many short white hairs on its dorsum; wing spots rather distinct. Abdomen black, thinly covered with short, pale yellowish hair; base of ventral surface at least, and sometimes the hind margin of some of the segments, yellow; ventral surface of eighth sternite with pale yellow hair; hypopygium and wing-spots similar to *strigata*. Length 12-15 mm.....*lenebrasa* Coq
 Thorax without white hairs, wing spots indistinct. Mesonotal vittae black. Abdomen black, hind margins of segments, except the first, and lateral margins yellow, sparsely covered with very short, yellowish hair; hypopygium small; hind margin of ninth tergite destitute of processes. Length 14 mm. (σ^7).....*gelida* Coq
145. Fuscous species146
 Colored otherwise149
146. Abdomen striped147
 Abdomen without longitudinal stripes, posterior margin of abdominal segments paler*148
147. Posterior margin of abdominal segments not paler, the three longitudinal stripes black. Mesonotum with six brown lines, the median stripes broad, laterals narrow. Eighth sternite with two deep folds or depressions; posterior margin of ninth tergite with two very small points; ninth sternite with median, whitish line, lateral angles with long, slender processes; wings hyaline, one or two indistinct, whitish peristigmal spots and a similar spot in the discal cell. Length 12 mm. (σ^7).....*stalactoides* †Doane
 Posterior margin of abdominal segments paler, dorsal stripe paler. Antennae wholly brown; mesonotum gray, three very broad fuscous vittae; lateral margin of abdominal segments paler; hypopygium small, ninth tergite with median, short rectangular process, the lateral angles of which are produced into sharp, black points; ninth sternite deeply and narrowly incised; wings with brownish tinge, middle portion somewhat whitish-hyaline; ante-stigmal spot indistinct. Length 14 mm. (σ^7).....*diluta* Doane

*Posterior margin of abdominal segments very indistinctly paler in dejecta Fab.

†Appears closely allied to *cineracea*, Coq.

148. Antennae wholly fuscous; mesonotal vitta marginate. Eighth tergite scarcely visible except at the sides; eighth sternite entire, not emarginate; ninth tergite with two short, blunt marginal teeth; ninth sternite with deep V-shaped incision. Wings light fuscous. Length 10-12 mm. *dentata* Fall.
- Antennae brown, basal joints yellowish; mesonotum with four brown stripes, not margined. Abdomen brown, basal segments yellowish; eighth sternite very large, very slightly emarginate, lateral angles with irregular shaped appendages; ninth tergite large, the lateral angles produced into long, somewhat curved, beardlike processes, which are concave within; posterior margin between these processes with two acute, triangular teeth; ninth sternite divided by a deep, broad membranous depression; pleural plates distinct. Wings hyaline. Length 17 mm. (♂) *tergata* Doane
149. Head and thorax yellow. Joints of flagellum fuscous; mesonotal vitta very faint. Abdomen yellow at base brownish posteriorly; eighth sternite produced; narrowed posteriorly, with shallow, broad emargination, lateral angles with a pair of conical processes, bearing a pair of long, curved bristles; ninth tergite with deep median furrow, posterior margin with a pair of short, broad, blunt teeth; ninth sternite with deep, shield-shaped incision the sides of which bear a pair of rectangular plates. Wings hyaline, stigma indistinct, brown; ante-stigmal spot faint. Length 18 mm. (♂) *hyalata* Doane
- Head and thorax not yellow. 150
150. Head and thorax shining black. Antennae wholly black; thorax margined with yellow; abdomen shining, sides and posterior margins of segments yellow, eighth sternite not emarginate, hypopygium small, ninth tergite small, short and almost concealed by the reflected, upper appendages; ninth sternite with suture-like incision, the posterior margin emarginate. Wings pale brown, ante-stigmal spot small but distinct. Length 9-16 mm. *apernax* O. S.
- Head and thorax not shining black. 151
151. Head subfuscous, thorax paler; antennae yellowish-brown, base of flagellar joints black. Lateral and posterior margin of abdominal segments paler; hypopygium small. Wings pale brownish, stigma colorous, ante-stigmal spot not very distinct. Length 13 mm. *umbrosa* Loew
- Head and thorax ferruginous. 152
152. Southern species; legs very long, thorax trivittate; posterior margin of abdominal segments paler. Length 16 mm. *perlongipes* Johnson
- Northern species; legs not unusually long. 153
153. Posterior margin of abdominal segments paler; base of abdomen not paler, the latter with broad dorsal stripe. Length 21 mm. *triplex* Walker
- Base of abdomen pale, posterior margin of segments not, or indistinctly paler. Length 16-20 mm. *duplex* Walker
154. Joints of flagellum distinctly bicolorous; yellowish species. 155
- Joints of flagellum unicolorous. 156
155. Large form; outer joints of flagellum fuscous; thorax with five stripes. Posterior margin of abdominal segments paler. Wings pale tawny, irregularly colorless behind the costal border; veins dark. Length 16 mm. *borrealis* Walker
- Very small; all the joints of the flagellum bicolorous. Mesonotal vitta scarcely recognizable. Posterior margins of abdominal segments slightly infuscate, hypopygium small; ninth tergite relatively large, separated from the side pieces by a distinct suture, posterior margin slightly emarginate; ninth sternite with Y-shaped incision; eighth sternite rounded posteriorly, pleural suture present, straight. Length 6 mm. *annulicornis* Say

156. Color yellow, gray or fuscous.....157
 Color black; posterior margin of abdominal segments gray.....164
 157. Basal joints of antennae yellow.....158
 Basal joints of antennae not yellow.....161
 158. Yellowish species.....159
 Fuscous species.....160
 159. Antennae long, more than half the length of the body, thorax vittate.
 Abdomen brownish. Wings grayish, stigma pale brown. Length
 14 mm.....*disjuncta* Walker
 Antennae less than half the length of the body; three vittae of thorax as
 well as of the abdomen, faintly indicated; eighth sternite extending up
 on the sides and much produced posteriorly, posterior margin rounded,
 with lateral, membranous appendages; ninth tergite very large,
 posterior angle produced into a pair of thick, heavy, slightly curved
 horns, posterior margin with two broad, flattened teeth; ninth stern-
 ite almost concealed by the eighth, posterior margin biemarginate.
 Wings hyaline, costal and subcostal cells and stigma with yellowish
 brown tinge. Length 17 mm. (♂).....*sternata* Doane
 160. Abdomen with broad dorsal stripe, basal part of ninth sternite with
 prominent carina. Mesonotum with faint trace of two cinereous lines;
 posterior margin of abdominal segments gray; hypopygium small,
 posterior margin of ninth tergite with crescent shaped incision; ninth
 sternite with crescent shaped incision. Wings with brownish tinge,
 subcostal cell and stigma slightly darker brown. Length 13-16 mm.
carinata Doane
 Abdomen with lateral and ventral stripes; ninth sternite not carinate.
 Mesonotum with three indistinct vittae; posterior margin of abdominal
 segments paler; ninth sternite ending in two short, blunt points; ninth
 sternite with deep incision, containing a pair of long, membranous
 appendages. Wings with slight grayish tinge, stigma and veins brown
 the fifth posterior cell is not in contact with the discal cell. Length
 13-15 mm.....*sulphurea* Doane
 161. Gray species.....162
 Fuscous species.....163
 162. Thoracic stripes margined; lateral and posterior margin of abdominal
 segments margined with yellowish. First antennal joint gray. Hypo-
 pygium medium sized; ninth tergite large, convex, narrowed posteri-
 orly and terminating into a short, rounded process; ninth sternite
 very large, protuberant, narrowly divided, subcarinate in its basal
 half, about the middle of the incision is a slight protuberance, densely
 covered with short hair; pleural suture nearly straight, evanescent
 posteriorly. Wings pale brownish, somewhat infusate at the apex,
 veins and stigma brown. Length 8 mm. (♂).....*cincla* Loew
 Thoracic stripes not margined, lateral ones ill defined; abdomen with
 fuscous dorsal and ventral stripe. Head and thorax more or less
 clothed with pale, erect soft hairs. Hypopygium small. Wings with
 whitish tinge, veins and stigma brown. Length 9-13 mm.....*besselsi* O. S.
 163. Head with two small, tumid processes just above the base of the anten-
 nae; abdomen with three dark fuscous stripes, posterior margin of seg-
 ments paler. Mesonotum gray with five fuscous stripes. Hypopy-
 gium small, ninth tergite with U-shaped incision; ninth sternite with
 deep narrow incision. Wings with grayish tinge, somewhat darker
 along the veins and in the middle of the cells, stigma brown, praefurca
 short. Length 10-14 mm.....*bituberculata* Doane
 Head without processes, dorsal abdominal stripe, if at all, very faint.
 Antennae rather long; mesonotum with median black line and two
 lateral indistinct, paler lines. Eighth tergite concealed except later-
 ally; hypopygium very small, ninth tergite with wide, crescent shaped
 incision; ninth sternite with lateral appendages. Wings uniformly red-
 dish-brown, stigma concolorous, veins brown. Length 9-10 mm. (♂).
illustris Doane

164. Abdomen with distinct, reddish brown dorsal stripe, lateral margins of segments not paler. Mesonotum with three gray vittae, median indistinct. Hypopygium small, ninth tergite with a broad lobe on each side of the posterior margin; ninth sternite with deep narrow incision, with two pairs of broad appendages. Length 13-15 mm. *costellata* Doane
- Abdomen not striped, lateral margin of segment gray. Head and mesonotum velvety black, latter with four rather indistinct grayish lines. Hypopygium small but rather long, ninth tergite deeply incised; ninth sternite with very deep, broad incision. Wings with grayish tinge stigma brown, veins brown, except at base of discal and second submarginal cell where they are white. Length 11-15 mm. *cericula* Doane
165. Wings of the male normally developed. 166
Wings of both sexes* reduced in size or rudimentary 167
166. Wings of female about one half the size of those of the male. Brownish-yellow; basal three joints of antennae yellow, remainder dark brown; mesonotum vittate; abdomen with three darker stripes; eighth sternite somewhat crescent shaped, lateral margin with subtriangular appendages; posterior margin of ninth tergite somewhat crescent shaped; ninth sternite almost divided by a deep narrow, U-shaped incision; pleural plates present. Wings hyaline with smoky tinge; a whitish, ante-stigmal spot extends into the base of the fourth posterior cell; a whitish spot beyond the stigma. Length 16-20 mm.; of wings, male 18 mm., female 10 mm. *Williami* Doane
- Wings of female much more reduced. *simplex* Doane
167. Wings greatly reduced in size but retaining the wing-form; 4-9 mm. long. 168
Wings reduced to mere irregular shaped pads, less than one half the length of the halteres. 169
168. Brownish yellow, thorax light yellow, stripes yellow (often indistinct). Antennae brown, basal joints yellow; abdomen with dorsal, lateral and ventral stripes; eighth sternite with broad, shallow median incision, lateral margin with broad subtriangular plates; ninth tergite with broad, circular incision with two short, median triangular processes. Wings distorted, variable in size, veins crowded. Length, male, 15 mm.; wing 5-9 mm.; female, 22 mm.; wing 5-6 mm. *vestigipennis* Doane
- Cinereous, thorax cinereous with four rather broad, brown stripes. Antennae brown, basal joints yellow; abdomen with dorsal and lateral stripes. Wings much reduced in size (♀), but little longer than the halteres. Length 26 mm. (♀); wings 4 mm. *sylvestra* Doane
169. Brown; antennae wholly brown; thorax with median darker stripe; halteres rather long and slender; abdomen with broad dorsal stripe; hypopygium rather small, ninth tergite with median groove and with deep, broad U-shaped incision containing two short, sharp processes; ninth sternite almost completely divided by a narrow deep, V-shaped incision. Length 4-6 mm. *quagga* Doane

APPENDIX.

The following two species were not included in the synopsis:

T. pratorum Kirby.

Head and thorax slate colored, the latter with four brown stripes; antennae fuscous, scape yellow. Abdomen yellow, with a fuscous dorsal stripe; hypopygium black. Wings subfuscous, clouded with white in the male, one or two fuscous spots near the anterior margin, stigma black. 24mm.

Wings of female not clouded with white.

T. simulata Walk. ♀.

Fuscous, palpi and antennae black, the latter about one half the length of the thorax, fuscous, scape tawny, stripes indistinct. Abdomen dull testaceous, with fuscous stripe. Wings hyaline with several brown spots, which are darkest along the costa. 20mm.

*Male of *sylvestra* not known.

†See under 37.

List and Bibliography of the North American species of the genus *Tipula* L. described since the publication of the Catalogue of the North American Diptera, by Prof. J. M. Aldrich.

- acutipleura* Doane. Annals Ent. Soc. of Amer., Vol. V, p. 42. San Diego, Cal.
albinnacula Doane. Annals Ent. Soc. of Amer., Vol. V, p. 51. Arizona.
alta Doane. Psyche, Vol. XVIII, p. 161. Keyport and Olympia, Wash.
alta Doane. Annals Ent. Soc. of Amer., Vol. V, p. 44. Landes, Wyoming.
aspersa Doane. Annals Ent. Soc. of Amer., Vol. V, p. 51. Pacific Grove, Cal.
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biarmata Doane. Annals Ent. Soc. of Am., Vol. V, p. 55. Keyport, Wash.
bifalcata Doane. Annals Ent. Soc. of Am., Vol. V, p. 55. San Diego, Cal.
biuncus Doane. Annals Ent. Soc. of Am., Vol. V, p. 58. Southern California.
californica Doane. Annals Ent. Soc. of Amer., Vol. V, p. 49. Palo Alta, Cal.
coloradensis Doane. Psyche, Vol. XVIII, p. 164. Tabernash, Col.
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Doane. Jour. N. Y. Ent. Soc. IX, 121 (contaminata).
cylindrata Doane. Annals Ent. Soc. of Am., Vol. V, p. 46. San Diego, Cal.
derbyi Doane. Annals Ent. Soc. of Am., Vol. V, p. 47. Stanford University, Cal.
flavicauda Doane. Annals Ent. Soc. of Am., Vol. V, p. 57. Montana.
flavocauda Doane. Annals Ent. Soc. of Am., Vol. V, p. 60. San Diego, Cal.
flavomarginata Doane. Annals Ent. Soc. of Am., Vol. V, p. 46. San Diego, Cal.
fulvipes Doane. Annals Ent. Soc. of Am., Vol. V, p. 45. Grand Coulee, Wash.
fulvilineata Doane. Annals Ent. Soc. of Am., Vol. V, p. 61.
Doane. Jour. N. Y. Ent. Soc., IX, 124 (graphica).
incurva Doane. Annals Ent. Soc. of Am., Vol. V, p. 43. Nebraska.
jejuana Johnson. Prof. Boston Soc. Nat. History, Vol. XXXIV, p. 132. Wellesley, Mass.; Riverton, N. J.
madera Doane. Psyche, Vol. XVIII, p. 162. Carte Madera Creek, near Stanford University; Stanford University.
marina Doane. Annals Ent. Soc. of Am., Vol. V, p. 41. Palo Alta, Cal.
neocomeri Doane. Psyche, Vol. XVIII, p. 163. Deer Park, Cal.
nigrocorporis Doane. Annals Ent. Soc. of Am., Vol. V, p. 45. San Diego, Cal.
occidentalis Doane. Annals Ent. Soc. of Am., Vol. V, p. 59. San Diego, Cal.
olympia Doane. Annals Ent. Soc. of Am., Vol. V, p. 61.
Doane. Jour. N. Y. Ent. Soc., IX, 115 (concinna).
oropezoides Johnson. Psyche, Vol. XVIII, p. 131. North Adams, Mass.; Framingham, Mass.; Hazelton, Pa. Dietz.
pacifica Doane. Annals Ent. Soc. of Am., Vol. V, p. 48. Deer Park, Placer Co., Cal.
pellucida Doane. Annals Ent. Soc. of Am., Vol. V, p. 61.
Doane. Jour. N. Y. Ent. Soc., IX, 104 (clara).
planicornia Doane. Annals Ent. Soc. of Am., Vol. V, p. 52. San Diego, Cal.
pyramis Doane. Annals Ent. Soc. of Am., Vol. V, p. 53. Pyramid Lake, Nevada.
quaylii Doane. Psyche, Vol. XVI, p. 18. Yuba City, Cal.
rokweri Doane. Psyche, Vol. XVIII, p. 165. Big Horn Co., Wyoming; East Bolter, Can. Dietz.
rupicola Doane. Annals Ent. Soc. of Am., Vol. V, p. 50. Oak Creek Canon, Arizona.
rusticola Doane. Annals Ent. Soc. of Am., Vol. V, p. 47. San Diego, Cal.
spatha Doane. Annals Ent. Soc. of Am., Vol. V, p. 59. Arizona.
sternata Doane. Annals Ent. Soc. of Am., Vol. V, p. 56. Stanford University, California.
subeluta Johnson. Bull. Amer. Museum Nat. History, Vol. XXXII, p. 42. Everglade, Florida.
sylvestra Doane. Psyche, Vol. XVI, p. 18. Pacific Grove, California.
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ungulata Doane. Annals Ent. Soc. of Am., Vol. V, p. 54. San Diego, Cal.
vestigipennis Doane. Psyche, Vol. XV, p. 47. San Francisco, Stanford University, California.
vittatipennis Doane. Annals Ent. Soc. of Am., Vol. V, p. 61.
Doane. Jour. N. Y. Ent. Soc. IX, 119 (albovittata).
Williamsii Doane. Psyche, Vol. XVI, p. 14. San Francisco, Cal.

SOME PEMPHIGINÆ ATTACKING SPECIES OF POPULUS IN COLORADO.

By C. P. GILLETTE

Thecabius populimonilis Riley.

This species was described by Dr. Riley, who recorded it from Greeley, Colorado, and from southern Kansas. He described the alate female of the second generation taken during July, and said that it always occurred solitary in the galls. The description fits the examples that we have taken during the same month.

Thomas in his *Eighth Report as State Entomologist of Illinois*, page 205, copies Riley's description, but adds nothing to it.

Oestland in his *Synopsis of the Aphididae of Minnesota*, page 24; and Packard in his *Forest Insects*, page 434, list this species.

Cowen in Bulletin 31, Colorado Experiment Station, page 116, listed this species as occurring at Fort Collins and Hotchkiss in Colorado, the latter place being on the western slope of the Continental Divide. Cowen also stated that only one louse seemed to reside in a gall.

Hunter lists this species in his *Aphididae of North America*.

In the *Journal of Economic Entomology* for 1909, page 356, the writer recorded what seemed to be this species infesting the margins of the leaves of *Populus trichocarpa* at Portland, Oregon, and observed that there was but a single large louse in each gall, all of which were becoming winged, and that the young of these lice were migrating to the young leaves as soon as born, where they were forming new galls for themselves.

In 1910, the University of Nebraska published a manuscript on the "Aphididae of Nebraska," which included notes on this family prepared by the lamented Thomas Albert Williams, which again copies the original description and extends the range of this species to Squaw Canon, Sioux County, Nebraska, and credits Professor Bruner with recording the species in Idaho and Utah.

Dr. Edith M. Patch, in Bulletin 213 of the Maine Experiment Station (June 1913) has extended the habitat of this insect to the cotton woods of Maine, where she has taken the galls and their inmates upon the leaves of *Populus balsamifera*.

In this Bulletin Dr. Patch has evidently overlooked the fundatrix or stem-mother and her gall, and has described an apterous second generation female instead.

The fundatrix of this species is undescribed and apparently has been unrecognized until the present year (1913).

On June 4, 1910, Mr. L. C. Bragg took a leaf of *Populus angustifolia* bearing the fundatrix gall, but its identity was not suspected until the gall (Plate I, figure 1) was discovered by the writer the past summer and associated with the production of the galls at Manitou and Colorado Springs on June 25th. At these places the galls were taken just as the second generation lice were beginning to leave the galls, which they do soon after birth, to go in search of the very young tender leaves at the tips of the twigs, upon which they locate, one in a place, along a line about midway between the midrib of the leaf and one of its margins, on the under side. The small galls on the tender new leaves were first seen, and a search for the source of the lice producing them resulted in the discovery of one of the pocket-like galls containing the fundatrix and a few of her newly born young, on a full grown leaf well down on the stem. This quickly solved the mystery as to the source of the lice that were producing the galls on the tender new leaves. In the next two hours a handful of these galls with their inmates were collected, and they were located in nearly every case by first finding the galls on the terminal leaves. At this time, most of the stem mothers had not begun to give birth to the young gall makers at Manitou.

The fundatrix gall, Plate I, figure 1, is very similar to the somewhat smaller galls of the later generations, (figures 9 and 10) averaging about 10 mm. in length, and is closed except for a narrow longitudinal slit opening below, which allows the young to escape as they are born. None of these young stay to feed with their mother in the gall.

Description of Fundatrix, Plate I, figure 2.

General color, slatey gray, due to a white powdery covering everywhere upon the surface of the body, without cottony threads, or with a few, only, about the lateral and posterior margins of the body. Beneath the powder, the body is of a dull, yellowish, olive green; head legs and antennæ blackish; body about 3.50 long by 2.25 broad; antenna (figure 3), .52; hind tibia, .45, hind femur, .55; beak very short, not attaining the second pair of coxæ; joints 3 and 5 of the antenna sub-

equal; joint 4 shortest; joints 1 and 2 and 4 about equal; 1 and 2 together about as long as joint 3; permanent sensoria only, and these are surrounded with cilia.

Described from specimens taken at Manitou and Colorado Springs, Colorado, June 25, 1913, by the writer.

Alate Fundatrigenia.

This seems undoubtedly to be the form originally described by Dr. Riley, and is distinguished by the sensoria of the antenna in his drawing. Riley shows three transverse sensoria on joints 4 and 5, and this is the common number in the examples we have had for study, while in the later and smaller winged sexupara there are usually no sensoria on joint 5 but the permanent one. On joint 3 (figure 4) there are from six to nine, usually seven or eight, sensoria present and there are three to four, usually three, on joint 4; two to four on joint 5, but usually three; none but the permanent sensorium on joint 6; and a well developed spine near the base of joint 3. Our examples differ from those described by Riley by being somewhat larger, as indicated by the alar expanse, which, in our examples, varies little from 9 mm.; and in the length of the body, which, in our examples, measures from 2.75 to 3.00.

The Apterous Fundatrigenia.

What I take to be this form are light cinnamon brown in color with head and tarsi black and with more or less darkened antennæ and legs. Length, 3.00; width, 1.90; antenna, .60; hind femora, .55; tibia, .45; beak very short, not reaching the second pair of coxæ; joints 1 and 2, and 4 and 5 of the antenna (figure 6), sub-equal; joint 6 longest; joint 3 nearly as long as joint 6 without the spur; joints 4 and 5, swollen and somewhat bead-like in appearance; permanent sensoria with cilia about their margins.

Described from specimens taken in the foothills near Fort Collins from July 19th to August 14th, and at Manitou August 9th.

On August 9th, I spent the day at Manitou studying this louse. The mature galls that were occupied were found inhabited in each case by one apterous female, probably a *fundatrigenia*; a few, 6 to 10, growing larvae and pupæ, and a small number of first instar lice; some of the last were migrating to terminal leaves and forming new galls just as the young from the stem-mothers did earlier in the season. The partly grown lice that were staying with the gall-mothers seemed all to be developing into winged individuals. All that were half grown or more gave plain evidence of this, and in one gall I found a winged adult with the apterous mother and numerous pupæ and young lice. The alate louse was a sexupara and is like the many mounted specimens that we have of this form taken in former years and again this year, late in the season.

After about the 10th of August, these alate sexupara have been common in the galls at Boulder, Fort Collins and Manitou, being still common in the galls at the last named place as late as September 20th, when there were still many larvæ and pupæ.

It is difficult to account for all the gall-mothers being apterous in August and September, when we thought that all we had noticed early in the season were winged or pupæ and solitary in the galls. Probably the explanation is that the late part of the second generation, the young from the stem mother, were apterous and remained to give birth to the two forms that occur in the galls from about the last of July on through the summer. These apterous gall mothers are certainly the parents of the alate forms (sexupara) that develop with them in the galls during August and September. The young larvæ were still producing galls at Manitou, August 9th and I found very young galls as late as September 20th at Manitou this year.

Late Apterous Form.

Described from specimens taken at Boulder, August 31, 1913, by L. C. Bragg, and at Manitou, September 20 by the writer.

Upon some of the sprigs brought from Boulder young lice were still locating on tender new leaves at the tips of the twigs for the formation of new galls, though on most of the twigs terminal buds had formed. Most of these galls contained a single apterous female that was readily distinguished from the other lice in the gall by its being more orange yellow in color. I found from eight to fifteen lice in each gall, staying with their apterous mothers. The former were in many instances, adult, and always winged when fully grown, and were also all sexupara. These gall mothers were still giving birth to a few of the dark colored young that migrate from the parental gall to form new galls on the tender leaves.

The adult apterous females in these galls were different from those found at Manitou and Boulder earlier in the year, by being much smaller and by having five jointed antennæ (figure 7) instead of six in all of the many specimens examined, the fourth joint being short and bead-like, and the entire antenna very much resembling the antenna of the fundatrix. The earlier form also showed a tendency to combine joints 3 and 4 and become 5-jointed. Length of body, 1.80; antenna, .38; joint 3 as long as joint 5 with the spur; otherwise like the earlier form.

Sexupara.

This form is rather markedly different from the *Fundatrigenia* by being distinctly smaller by having fewer sensoria on the antennæ (figure 5) and by having several lice living together in a gall along with the apterous mother just described.

Length of body, 1.75 to 2.00; wing, 2.00; antenna (figure 5), .60, sensoria:—joint 3, from 4 to 7, but nearly always 5; joint 3, 2 to 4, but nearly always 3; joints 5 and 6 with permanent sensoria only; joint 3, slightly longer than 6, but not as long as joint 6 with the spur included; joints 4 and 5 about equal, permanent sensoria ciliated; sensoria on short transverse lobes or ridges which do not extend nearly around the antennal joints; spur on joint 3 rather weak.

Sexuales.

The alate sexupara begins giving birth to the sexual forms soon after leaving the galls. Those that escaped from the galls collected August 31st, had given birth to many males and oviparous females in the breeding cage September 1st. The females are greenish in color and measure about .90 in length; the males are pale yellow in color and measure about .60 in length; neither have beaks with which to take food; about 4 to 5 of each are born from one female.

The fact that this species is on the cotton woods from the time of formation of the stem mother gall early in the summer until the development of the sexupara, it seems strongly probable that this species has no alternate host plant. The sexuales must be deposited upon the cottonwood or the stem mother could hardly be upon the leaves of these trees early in the spring.

SUMMARY OF LIFE HISTORY.

From all the data that we have been able to gather to the present time it seems probable that the life history of this species is about as follows:

The fundatrix hatches upon the cottonwood in the spring from eggs deposited upon these trees the previous fall. These stem mothers locate between the midrib and the margin of one of the early developing leaves and produce almond shaped galls similar to those that are produced on the terminal leaves, by their descendants, later in the season. From this stem-mother gall, the young escape almost as soon as born and locate on the tender new leaves, as did their mother, between the margin and midrib, each louse being solitary and producing an almond shaped gall. Apparently the lice of this second generation all become winged at first, it is certain that many do, and leave the galls, while a portion, especially of the later lice that are born, remain apterous, stay in the galls, and give birth to a third generation. These young, like the young from the stem mother, also migrate to the new leaves to continue the production of galls, each of which harbors but one louse at first, but a portion of the young of this brood remain with the mother in the gall

and become winged sexupara, of which ten to twelve may be found in a single gall with the parent. These winged sexupara begin to emerge in the vicinity of Fort Collins about the first week of August and continue to emerge till the last of September and soon give birth to the sexual forms.

The apterous females (*fundatrigenia* or *virgogenia*), occur in leaf galls, at least from about July 17th to September 20th, a portion of their young also staying in the galls with them and becoming sexupara, and a portion migrating as soon as born to form new galls, as late as September 1st. If this interpretation is correct, the alate fundatrigenia in this species seems only to distribute the species from one tree to another, but we have no observations that fully confirms this hypothesis. *The Galls.* (Figures 1, 9, and 10.)

Throughout the summer the galls are started upon the very tenderest young leaves only, by first instar lice which locate on the ventral surface of the leaves. There may be from one to a large number of these galls on the leaves, the entire surface of the leaf being included in gall development very often when the lice are abundant. The galls are paler green than the remaining portions of the leaves; are long oval in general form; commonly 6 to 8 mm. in length, but may be as long as 10 mm., and always upon the upper or dorsal surface of the leaf.

While it is common to find these galls abundant upon the narrow leaved cottonwood, *Populus angustifolia*, in Colorado, we have never taken one of these galls on any of the several varieties of broadleaved cottonwoods which are more common. It is entirely possible, therefore, that the specimens recorded in this paper from other states may belong to a distinct species. The galls sent from California by Professor E. Bethel, George P. Weldon, and A. C. Maxson; from Maine by Doctor Edith M. Patch; from Michigan by Professor R. L. Pettit, and those taken by the writer at Portland, Oregon, were all from broad leaved cottonwoods. On the broad leaved cottonwoods, the galls are usually placed near the leaf margin so that the long diameter of the gall is parallel with the leaf margin.*

*Since writing the above paper Mr. George M. List has collected additional material of this species for me at Manitou, on October 18th. Some of the galls taken on this date still contain the virgogenia and alate sexupara as described above and many sexual males and females. Probably it is only the belated sexupara that deposit their sexual young in the galls. This completes the round of development on the cottonwood except for the egg stage, which doubtless occurs on this tree, also.

The specimens of this species in the collection have been taken as follows.

FUNDATRIX.			
Manitou, Colo.,	6-25-13	<i>Populus angustifolia</i>	C. P. Gillette
Colorado Springs, Colo.	6-25-13	" "	C. P. Gillette
FUNDATRIGENIA			
Horsetooth Mountain	8-8-09	<i>Populus angustifolia</i>	M. A. Palmer
Spreckles, Cal.	7-27-13	" fremontei (?)	A. C. Maxson
Fort Collins, Colo.	8-11-12	" angustifolia	L. C. Bragg
Fort Collins, Colo.	8-11-13	" "	" "
Vanderbilt, Mich.		" candicans	R. L. Pettit
Boulder, Colo.	8-11-12	" "	L. C. Bragg
Sacramento, Cal.	8-1-13	" fremontei	E. Bethel
Horsetooth Mountain	7-19-09	" angustifolia	M. A. Palmer
Boulder, Colo.	8-25-12	" "	L. C. Bragg
Manitou, Colo.	8-9-13	" "	C. P. Gillette
Boulder, Colo.	8-31-13	" "	L. C. Bragg
Manitou, Colo.	10-18-13	" "	G. M. List
SEXUPARA.			
Manitou, Colo.	8-9-13	<i>Populus angustifolia</i>	C. P. Gillette
Manitou, Colo.	10-20-08	" "	" "
Big Thompson Canon	9-18-10	" "	" "
Boulder, Colo.	8-31-13	" "	L. C. Bragg
Manitou, Colo.	10-18-13	" "	George M. List
SEXUALES.			
Manitou, Colo.	10-18-13	<i>Populus angustifolia</i>	George M. List.

Cornaphis, New Genus.

The genus is closely related to *Asiphum* Koch. The wax plates are absent in the fundatrix but are present in the apterous fundatrigenia; the antenna of fundatrix, 5-jointed; of fundatrigenia, 6-jointed; permanent sensoria ciliated. In the type specimens the cubitus is simple, and the fundatrix, fundatrigenia and sexupara all develop in a gall together.

Cornaphis populi, New Species.

Producing galls on leaves of *Populus angustifolia*, which are merely a thickened and extended portion of the margin of the leaf which folds upon the upper surface producing a moon shaped, pod-like gall of a paler green color than the surrounding foliage, and often streaked with red. Galls usually measure from 15 to 18 mm. in length, and are about one-third as thick as the extreme length (figures 11 and 12).

I have never seen more than one of these galls on a single leaf, apparently each gall develops three generations of lice within it, the fundatrix and the fundatrigenia which are apterous, and the sexupara which is alate.

On July 15, 1913, the alate form was just beginning to acquire wings about Laramie, Wyoming. At this time, the fundatrix was still in the galls in a vigorous and active condition.

Description of Fundatrix, Figure 13.

The general color is a slatey gray, the body being covered everywhere with a fine, white powder; the head, four spots in a transverse row on the pro-thorax, the antennae and legs, including coxae, black; beak attaining third coxae; joint 2 of the antenna (figure 15) about three-fourths as long as joint 3; entire antenna, .40 long; apparently no gland plates on any part of the body; permanent sensoria surrounded with ciliary fringe; length of body 2.75. On the vertex, between the insertions of the antennae, is a slight tubercle, which is not very prominent in the fundatrix.

Fundatrigenia, Figure 14.

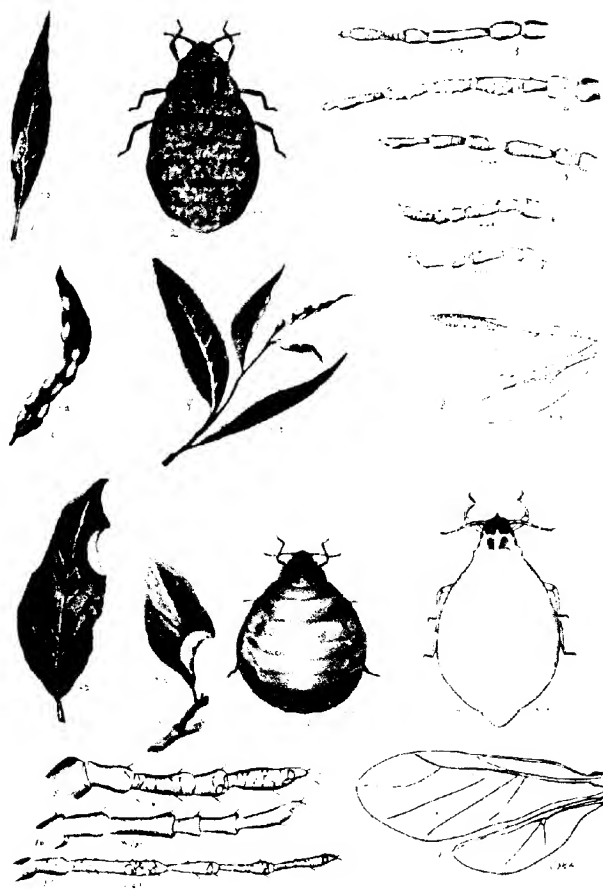
Apparently the young of the Fundatrix are all apterous, and their offspring, the third generation, all alate sexupara. The other possibility would be for the stem mother to give birth to two sets of offspring, the earlier ones being apterous individuals which later give birth to the sexupara, and the later ones developing into sexupara directly, which does not seem at all probable.

The adult apterous fundatrigenia is of a light straw yellow color and more or less covered with white powder, but there seem to be no tufts or patches of the waxy secretion upon the body; head including a prominent frontal spine, eyes and tarsi blackish; dorsum of head, usually four patches on the pronotum in a transverse line, legs and antennae dusky brown; beak attaining third coxae; antennae (figure 16) 6-jointed; third joint longest but barely exceeding joint six with the spur; joint 4 shortest, being about half as long as 3; length of body 2.50; antenna, .62. This form lives in the gall with the stem female and other descendants of the year.

Described from specimens taken at Laramie, Wyoming, July 15, 1913.

Sexupara.

General color, pale greenish yellow, with dusky head, antennae and tarsi; thorax a little darker than the abdomen; length 2 to 2.25; length of wing 2.75; length of antennae (figure 17) .90; median ocellus on a rather prominent tubercle, cauda broadly oval; joints of antenna about as follows: third joint longest, a little shorter than 4 and 5 together; joint 4 a little shorter than 5; joint 6 without spur equal to joint 5; sensoria very indistinct; about 3 to 5 broadly oval sensoria on the distal one-third of joint 3, one near the distal end of joint 4, and also the permanent sensoria on joints 5 and 6; cilia about permanent sensoria rather weak, but always present. The examples studied seem each to be able to give birth to about twelve of the sexuales.



Sexuales.

Pale green or yellowish green in color, the males being much the smaller and darker; mouth parts lacking.

We have taken this species as follows:

Monte Vista	6-22-13	<i>Populus angustifolius</i>	C. P. G.	Fundatrix
La Jara	6-23-13	" "	"	"
Pt. Collins	7-10-12	" "	L. C. B.	All stages
Laramie, Wyoming	7-15-13	" "	C. P. G.	"
Wood's Landing, Wyo.	7-15-13	" "	"	"

EXPLANATION OF PLATE.

PLATE LIX.

Figures 1 to 10, *Thecabius monilis*:

Fig. 1. fundatrix gall.

Fig. 2. fundatrix.

Fig. 3. Antenna of fundatrix.

Fig. 4. Antenna of alate fundatrigenia.

Fig. 5. Antenna of alate sexupara.

Fig. 6. Of apterous fundatrigenia;

Fig. 7. Alate apterous form, parent of sexupara.

Fig. 8. Wings of fundatrigenia.

Figs. 9 and 10. Galls, young and fully grown, on narrow leaved cottonwood.

Figures 11 to 18, *Cornaphis populi*:

Fig. 11. Young, and Fig. 12, a rather mature gall of this species.

Fig. 13. fundatrix.

Fig. 14. Fundatrigenia.

Figs. 15, 16 and 17, antenna of Fundatrix, fundatrigenia, and sexupara respectively.

Fig. 18. Wings of sexupara.

The enlargements are indicated with each figure. Figures are drawn by Miss Caroline M. Preston.

CORRECTION: Page 486, for Plate I read Plate LIX.

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